THE Petroleum Engineer

APRIL 1935

VOLUME VI NUMBER VII

A MAGAZINE OF METHODS FOR OPERATING MEN

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Independent Petroleum Association of America, Annual Meeting—November 4 and 5, Adolphus and Baker hotels, Dallas, Texas.

American Petroleum Institute, Sixteenth Annual Meeting—November 11, 12, 13, and 14, Biltmore Hotel, Los Angeles, California.

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SUBSCRIPTION PRICE—Single copies 15 cents. Domestic and foreign, $1.00 per year, three years $2.00, with the exception of Canada, where the price is $1.65 per year, three years $3.95.

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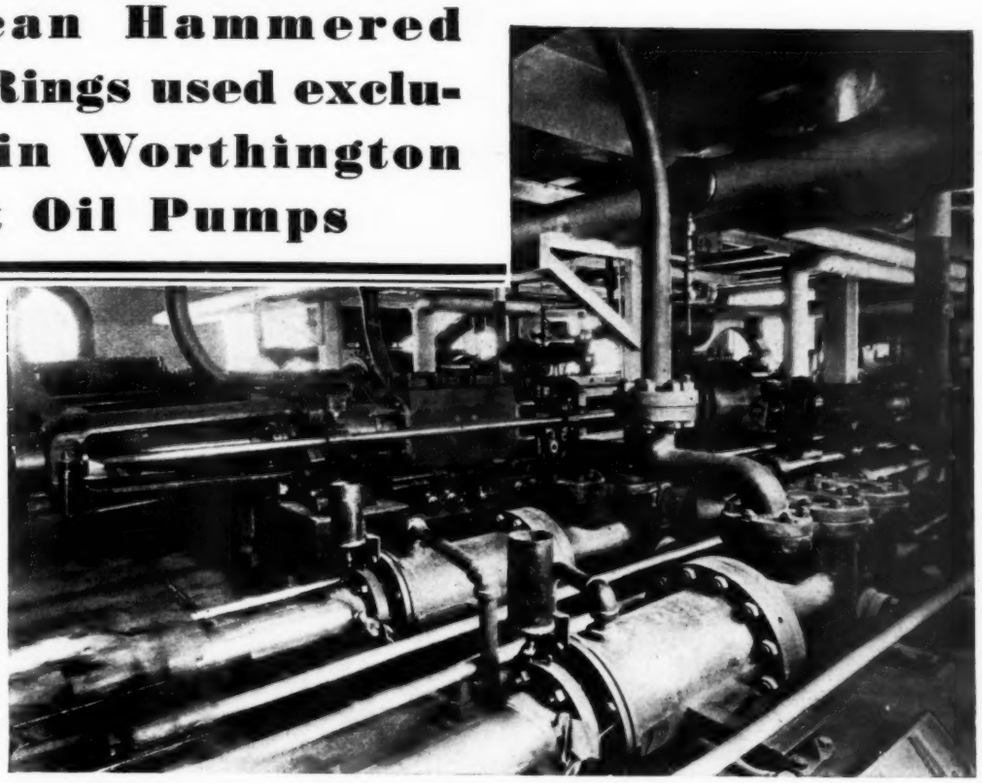

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The Course of Oil

By K. C. SCLATER

The Technical Witness

Inhibiting factors influencing expert technical testimony are revealed in an article, "The Technical Witness," published in The Journal of Accountancy, March, 1935. The author, David Donoghue, Fort Worth, Texas, has been for years in the oil business as a consultant, so speaks from experience. So pertinently does his discussion apply to the oil industry and so thought-provoking are the views expressed that the full text of the article is given herewith:

In this age of technical control of industry, the technical man is being drawn into many legal controversies regarding the regulation of industry by bureaucratic bodies as well as into the cases involving the disputes that arise in the ordinary conduct of business.

Lawyers will say, and cite judicial opinions in proof, that "expert" testimony is regarded by their profession as being highly untrustworthy. It might be well to pause here and allow the technical man to hazard a guess that "expert" testimony can hardly be much better than the ability of the lawyer who introduces it or of the counsel for the opposition whose duty it is to controvert it. It is difficult, if not impossible, to give technical testimony on a witness stand in an impartial and thoroughly technical manner and to tell "the truth, the whole truth and nothing but the truth." The whole truth is seldom brought out, due largely to the fact that it is not wanted by either side. Contributing factors are the limitations sometimes placed upon the presence of technical assistance in the court-room during the progress of testimony; the inability of some technical men to give intelligent advice to the attorneys during the progress of direct and cross-examination; and all too often the lack of experience and thorough preparation by both attorneys and technical men.

A technical witness should be as impartial as the judge hearing the case. Many attorneys fail to recognize this tendency on the part of the competent and experienced witness and proceed to ask questions calculated to arouse his ire. In self-defense, the witness may have to adopt tactics that overemphasize the importance of the testimony favorable to the side which employs him. On the other hand, shrewd lawyers recognize that an honest but indignant witness may be let into statements that will impeach his testimony.

Seldom is it found that one of the parties to a legal dispute is wholly right and the other wholly wrong. Occasionally a careful technical presentation of all available facts will cause a compromise or dismissal of the action before it comes to trial.

The technical witness should not be interested in the personalities usually involved in a court action. This is an attitude which can not be understood by many laymen, especially those whose thoughts and reasoning are inclined towards the political. The witness has facts and opinions to present, based on general and particular studies of the points at issue. His testimony, if preparation and studies have been sufficiently thorough, can be used by either side or both sides; and this is as it should be, if the litigants are not fearful of the truth, the whole truth.

Often it is represented to a prospective witness that his presence in court is desired to give evidence on some stated point only, and he finds that cross-examination is not confined to that particular subject and that he is being disqualified and humiliated because he is not prepared to answer all questions related to his profession. There is nothing to be done in such instances but to "take the gaff," unless the witness has enough foresight to get a statement of his position into the record before having to admit on cross-examination how inadequate his preparation has been.

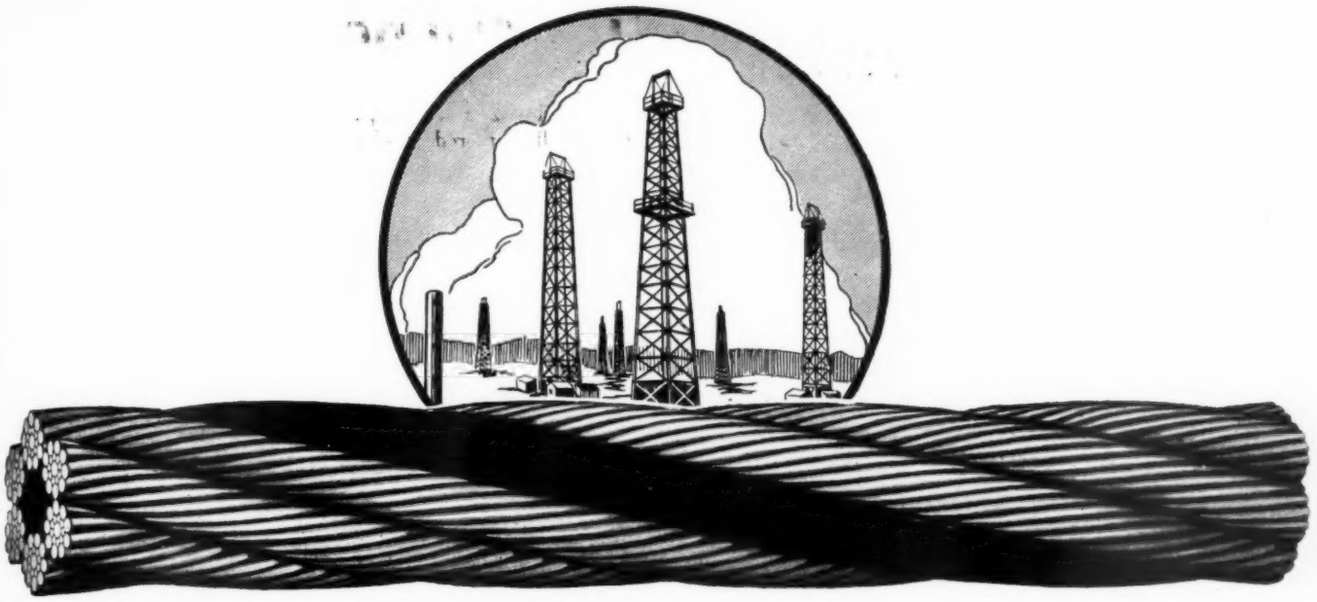
The ideal manner in which to present technical testimony would be for the presiding judge to appoint a competent technical man or board to examine into the merits of the case and make a written report to the court stating such facts as are available and such theoretical considerations as may be regarded as fundamental. Individual deductions and theories should be stated separately from the body of the report, and the expert or experts should be subject to cross-examination by both sides of the controversy. Then, if the attorneys had not thoroughly prepared themselves, they could point the finger of scorn in their own direction and not, as they now do, towards the so-called "expert" witness.

Lawyers are prone to desire, if not compelled to seek from a witness, only those facts that are favorable to their case. It is the duty of the opposing council to develop by cross-examination the evidence that modifies the import of the direct testimony, and no honest technical man should be the least chagrined by giving an answer damaging to his client in reply to a fair question.

As a practical matter, a witness should request that a copy of the transcript of his testimony be made available to him. Court reporters are not always familiar with technical words and expressions and sometimes corrections are necessary, and, most important, a review of the testimony will probably convince the witness that he should endeavor to confine his answers to "Yes," "No" and "I don't know."

Expert testimony is largely opinion testimony. It is well recognized that competent technical men will differ in opinions based on their understandings of a given set of facts. If the undisputed facts were available to all concerned, there would undoubtedly be less difference of opinion. The fear of attorneys that certain facts will have an unfavorable effect upon judge and jury leads to the suppression of facts. What, then, should members of the bar expect from the "experts" whom they bring to the witness stand? Then, too, they have another problem, solely theirs, the incompetent and the dishonest "expert." When a man has his day in court he is entitled to such legal assistance as his purse and inclinations may dictate, and if technical advice or testimony is also needed the same factors will govern the selection of an "expert."

The witness stand is a stage and the attorneys and witnesses who present a case in a manner that reflects preparation, knowledge, skill and ability have the best chance to receive the favorable verdict of judge and jury.



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« « « HIGHLIGHTS IN OILDOM » » »

New Allocation Method for Kettleman North Dome

Allocation of production among the wells of the Kettleman Hills North Dome field in the future will be determined upon a new basis. In ruling upon a complaint made by the Superior Oil Company and the Amerada Petroleum Corporation, Oil Administrator Harold L. Ickes has stated that oil production allowables of those two companies have been neither unreasonable nor inequitable when the production from their tracts is considered in relation to the oil output of the Huffman area of the field. He further stated, however, that the companies may have suffered from application of the intra-field allocations and authorized the Petroleum Administrative Board to determine, with a view to adjustment, the amount of oil, if any, the appealing parties, or others, may have lost.

Following an exhaustive investigation the board had arrived at the conclusion that the existing method of intra-field allocations did not result in the maximum recovery of oil, the efficient utilization of reservoir energy, or the prevention of irregular and premature water encroachment. It was recommended that a new method based upon the proper interpretation and application of sub-surface pressure data be sought. Until such a method can be worked out Administrator Ickes ordered, effective April 1, that each producing well in the field capable of such production shall receive a minimum allotment determined by the same method used for all other wells in California, the purpose of the minimum allotment plan being to assure recovery of actual lifting costs.

Administrator Ickes also has ordered the office of the oil umpire for the Central Committee of California Oil Producers to examine all other California fields where similar conditions may exist, so that, if found, adjustments can be made, following the same procedure as used for the Kettleman Hills North Dome field.

●

Many New Petroleum Laws for Kansas

The session of the Kansas Legislature just ended saw the passage of several laws affecting natural gas and crude oil, perhaps more than during any previous session in the history of the state. House Bill 279, which becomes effective July 1, is for the purpose of preventing the waste of natural gas. An important feature of the bill authorizes the state corporation commission to make rules and regulations fixing the gas-oil ratio of production to be allowed from wells producing both oil and gas, and prohibits the daily taking from a gas well of in excess of 25 per cent of its open flow. The law excludes from supervision and regulation all wells having an open flow of 750,000 cu. ft. or less.

House Bill 630 ratified the interstate compact for conservation of oil and gas that was entered into at a meeting in Dallas, Texas, in February.

House Bill 278 permits, in the interest of oil and gas conservation, "the repressuring by air, gas, water, or other fluid upon any oil-producing sand, strata, or formation that has produced oil for the purpose of recovering any oil that may be contained therein." Kansas is the second state to have such a statute, Pennsylvania having had a similar statute since 1915.

Senate Bill 195 relates to abandoning of oil and gas wells and repeals the ancient laws upon the statute books relative to the county plugging system. Wells will be plugged now under the direction of the commission and in the manner in which it prescribes and every protection will be given to fresh water strata.

House Bill 280 is a law permitting the owner of any oil or gas well that produces salt water "to return the salt water to any horizon from which any salt water may heretofore have been produced."

●

Oklahoma Passes Five-Cent Crude Oil Tax

Both houses of the Oklahoma Legislature have passed the administration-endorsed gross production tax on crude oil calling for an increase in production levies. The new bill provides a tax of five cents a barrel, whereas the old law was for three cents.

The tax of three cents a barrel yielded during the last fiscal year revenue to the extent of $4,790,603.62, and based on pipe line runs for 1934 the new levy should yield approximately $9,000,000. No time limitation was placed on the bill. Governor Marland had asked for a five-cent tax to run until June 30, 1936, when the rate would revert to three cents.

●

Cannot Produce from Two Sands

Operators in the Oklahoma City field have been notified by the proration department to proceed immediately to plug off, by setting pipe or cementing, the lower sands where attempts are being made to produce from the Cleveland sand. Eight wells are reported producing from both the Cleveland and Wilcox sands, and there may be others, it is said.

Rule 19 of regulations governing the conservation of natural gas and crude oil reads as follows:

"No well shall be permitted to produce both oil and gas from different strata unless it be in such a manner as to prevent waste of any character of either product. Therefore, if a strata should be encountered bearing gas and the owner, operator, or contractor should go deeper in search for other gas or oil-bearing sands, the stratum first penetrated and likewise each and every sand in turn, shall be closed separately, and if it is not wanted for immediate use, it shall be securely shut in so as to prevent waste, either open or underground."

●

Pressure Drop, Water Intrusion in East Texas

The Texas Railroad Commission cut East Texas' allowable from 3.6 to 3.45 per cent of the rated hourly flow on April 1. Decline in bottom-hole pressure and spread of salt water were the factors prompting the order. The average bottom-hole pressure decline during February was 11 pounds, and Gordon Griffin, chief engineer of the railroad commission, recommended that the allowable be cut as a means of retarding this slump in the flowing life of the field.

●

World's Deepest Producing Well

The Denver Producing and Refining Company, of Oklahoma City, during March completed at 11,230 ft. its No. 1 A-dah-noc, six miles east of the town of Binger, Oklahoma, in Caddo County. This is now the world's deepest producing well, replacing in that respect the Associated Oil Company's Lloyd 83 in the Ventura Avenue field, California.

The Gulf Production Company's No. 103 McElroy in Upton County, West Texas, at the last report drilling below 12,107 ft., is the world's deepest test. Last month in writing of this well and comparing its depth with that of the General Petroleum Corporation's No. 1 Berry, it was inadvertently stated that the latter was a producing well. Such is not the case. No. 1 Berry was drilled to 11,377 ft., but had a fishing job at bottom and is now idle.

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LATEST ACTIVITIES IN THE OIL FIELDS

SEVERAL tests have been started on the newly extended drilling zone in the Oklahoma City field. The Phillips Petroleum Company was the first to stake a location with its No. 1 Durland, followed closely by others. The extended area, involving more than 1000 acres, was made possible by an election held early in March, following a controversy of several months duration.

•

The Alice Sidney Oil Company's B-2 E. F. Gregory extends production in the Taylor sand horizon of the Lower Cretaceous in the Rainbow City field. Union County, Arkansas, a quarter of a mile southwest. The well flowed 825 bbl. of oil daily through 2-in. tubing at a total depth of 3377 feet.

•

Of interest recently was the production test made on the Consolidated Crude Corporation's No. 1 Bloemer-Jeppi, outpost well on the northwesterly flank of the Edison structure, Kern County, California. After being drilled to a total depth of 5567 ft., it was plugged back to 5514 feet. Seven-inch casing was cemented at 5240 ft. to shut off water, and 290 ft. of 4¾-in. liner run. Oil was circulated, replacing the mud, and swabbing was resorted to. The recovery of oil and gas was light. A large quantity of water was present, but inasmuch as it was fresh instead of salt water usually present at that depth, operators were of the belief that it might be coming from farther back up the hole, and were hopeful of the well.

•

The Fitts pool in Pontotoc County, Oklahoma, is rapidly growing into one of the state's major pools. Recent tests, made late in March, showed the potential of the field to be 233,876 bbl. daily, with a number of new wells being brought in each week. A southwest extension was given the field recently when the Burke-Greis No. 1 Chambers found production at a total depth of 4444 ft. in the Bromide formation. On the initial test the well flowed 585 bbl. per hour through casing.

An important extension was made to the Strawn sand horizon of the Knox-Manning field of Young County, Texas, when the No. 1 W. B. Harrison of Chas. E. Knox and associates swabbed 11 bbls. of crude per hour from sand and shale zones at 2702-33 ft. and 2757-58 feet. The well is approximately one mile due west of the Knox-Manning field.

•

S. G. Smith's No. 1 Decie in Brewster County, Texas, a wildcat 24 miles southeast of Alpine, has found production at 805 feet. Thirty-five bbl. of crude were bailed from the well and oil continued to rise in the hole.

•

The Gulf Production Company's No. 103 McElroy, the deepest hole in the world, is drilling below 12,065 ft. in sand and green shale, with a small amount of chert.

•

The Gypsy Oil Company with its No. 1 Keesling has given Rice County, Kansas, its 15th oil pool. The wildcat, seven miles southwest of Lyons, had 2100 ft. of oil standing in the hole. The well is drilled to a total depth of 3260 ft. with production from the siliceous lime.

•

Possibilities of a new pool in Live Oak County, Texas, was indicated when the Smith and Storey test No. 1 Frederick had a showing of oil and gas at a total depth of 5217 feet. The test is three miles northeast of the Lion Oil and Refining Company's wells in the McNeil area, and two miles north of the Lucas gas field.

•

The Peay Oil Company has obtained a show of oil in its No. 1 Denio test, south of the Byron field in Wyoming. At the last report it was at a total depth of 3440 ft., but was to be drilled deeper. It was estimated as a 30 to 40 bbl. a day well.

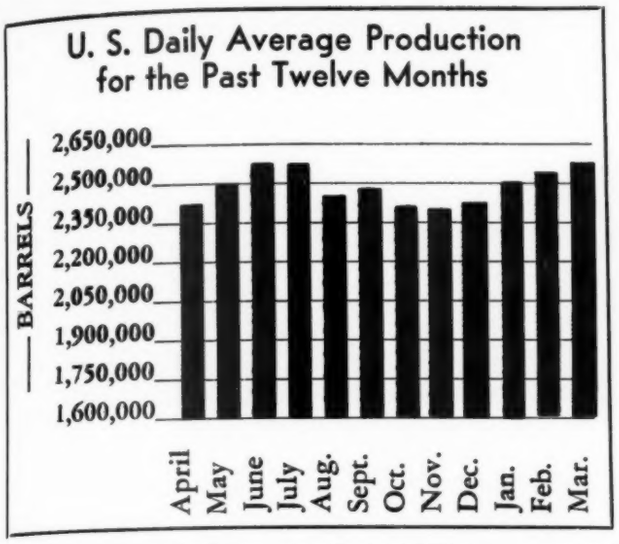
AVERAGE CRUDE OIL PRICES

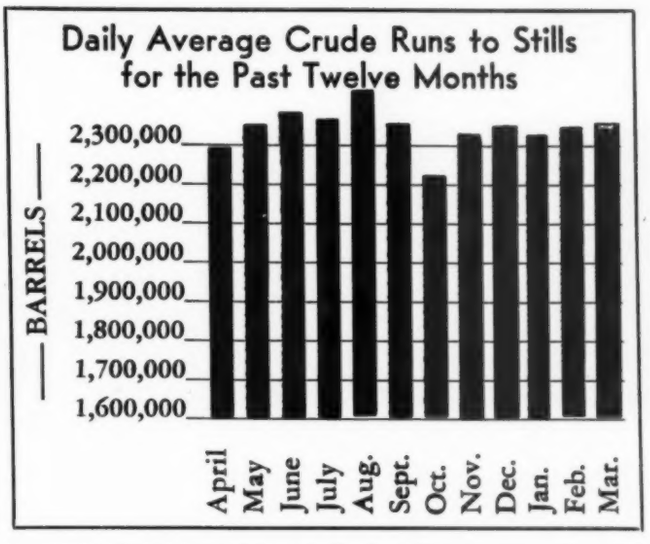
California		Louisiana	
Playa Del Rey	$ .90	North Louisiana	$ .95
Coalinga	.81	Gulf Coast	1.04
Signal Hill	1.12	Illinois	1.13
Montana	1.35	Kentucky	1.08
Wyoming	1.00	Indiana	1.12
Colorado	1.00	Ohio	
New Mexico	.75	Lima	1.30
Texas		Michigan	1.02
North Central	.95	Pennsylvania	
Panhandle	.51-.71	Bradford	2.35
West Texas	.70-.75	Southwest	2.02
Gulf Coast	1.04	Eureka	1.97
Darst Creek	.87	Buckeye	1.87
East Texas	1.00	Corning	1.32
Kansas	1.00	West Virginia	1.67
Oklahoma	1.00	Canada	2.10-2.17
Arkansas	.70		

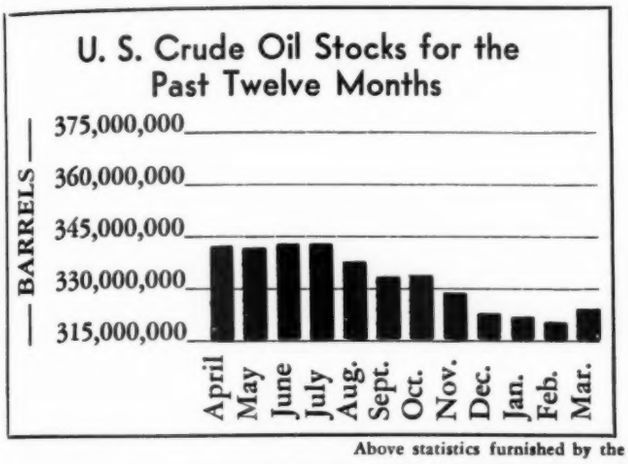
DAILY AVERAGE CRUDE OIL PRODUCTION
Furnished by A.P.I.

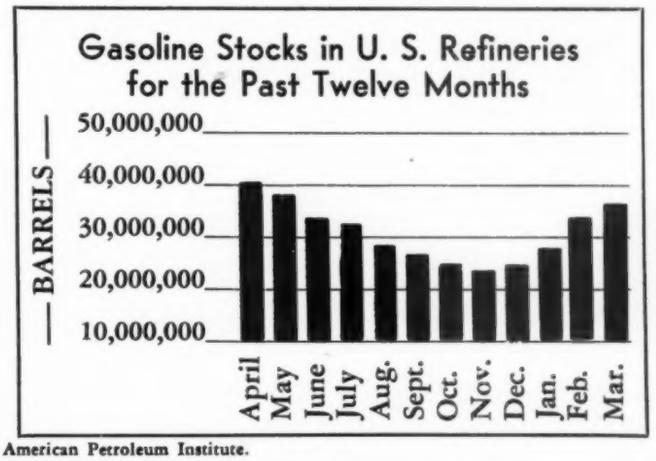
(Figures in barrels)

	Federal Agency Allowable Effective March 1	Week Ended March 23, 1935	Week Ended March 2, 1935	Week Ended March 24, 1934
Oklahoma	491,000	514,550	457,800	499,700
Kansas	139,700	153,050	146,400	124,500
Panhandle Texas		65,050	62,850	57,800
North Texas		57,600	57,550	55,300
West Central Texas		25,750	25,650	26,950
West Texas		152,900	150,300	138,400
East Central Texas		52,400	51,250	43,950
East Texas		446,100	438,300	433,550
Conroe		47,700	47,200	48,100
Southwest Texas		60,250	59,900	49,200
Coastal Texas (Not incl. Conroe)		134,250	129,850	111,450
TOTAL TEXAS	1,020,100	1,042,000	1,022,850	964,700
North Louisiana		23,050	23,000	28,050
Coastal Louisiana		95,050	94,400	45,200
TOTAL LOUISIANA	110,500	118,100	117,400	73,250
Arkansas	31,900	30,800	30,050	30,950
Eastern (Not incl. Michigan)	105,500	107,800	106,550	96,950
Michigan	31,600	36,900	33,350	26,400
Wyoming	35,100	33,000	31,400	30,150
Montana	9,500	10,300	10,800	7,000
Colorado	3,500	4,950	4,300	2,350
TOTAL RK. MT. ST.	48,100	48,250	46,500	39,500
New Mexico	49,300	47,050	47,250	42,350
California	492,600	501,600	456,700	491,500
TOTAL U. S.	2,520,300	2,600,100	2,473,850	2,389,800









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for March, 1935

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	344	341	119	214	3600	2	40	Rotary
Duval County	23	19	3	9	2300	2	22	Rotary
Archer County	66	49	12	62	660–1800	1 or 2	40	Rot.-Cab.
Conroe	7	6	2	6	2000–7400	3 or 4	40	Rotary
Refugio County	8	8	1	4	5200	2	38	Rotary
OKLAHOMA								
Oklahoma City	2	2	8	26	6500	3	39	Rotary
Pontotoc County	21	16	7	67	1800–4488	2 or 3	38	Rotary
Osage County	21	17	22	55	380–2850	2	37.5–40	Rot.-Cab.
KANSAS								
McPherson County	11	8	5	22	2900–4300	2	38	Rot.-Cab.
Harvey County	4	4	1	7	3450	2 or 4	37	Rot.-Cab.
Ellsworth Arch	56	46	36	115	3300	4	37	Rot.-Cab
CALIFORNIA								
Kettleman Hills	5	5	5	21	8300	3 or 4	40	Rotary
Long Beach	9	9	13	25	7000	3	36	Rotary

Field Activities by States for March, 1935

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1934 (In Barrels)
	March	February	March	February	March	February	March	February	March	February	
Arkansas	11	17	4	7	14	15	20	14	47	43	11,412,100
California	64	46	59	41	96	68	83	56	205	223	175,678,362
Colorado	2	1	2	1	....	....	2	3	24	30	1,168,000
Illinois	2	0	0	0	....	....	8	10	12	14	4,466,000
Indiana	6	25	4	21	....	....	1	1	30	49	813,000
Kansas	98	103	71	77	101	113	63	55	197	215	45,577,050
Kentucky	4	4	3	3	....	....	2	4	17	23	4,863,000
Louisiana	48	43	34	28	61	63	55	62	145	149	32,572,900
Michigan	20	27	15	19	30	26	130	130	155	131	10,589,600
Mississippi	1	3	0	1	....	....	2	1	14	13	Gas Prod.
Montana	3	3	3	2	....	....	10	7	40	39	3,797,000
New Mexico	26	18	19	16	....	....	19	17	93	86	16,529,050
New York	....	....	....	....	....	....	0	1	1	0	2,880,700
Ohio	87	121	59	91	....	....	51	42	184	174	4,291,000
Oklahoma	161	172	108	104	210	150	87	92	512	444	176,506,550
Pennsylvania	6	4	5	4	....	....	22	18	74	71	15,353,850
Texas	837	794	666	610	1284	903	410	369	1206	1011	380,848,000
West Virginia	53	62	42	53	....	....	19	14	68	73	4,043,550
Wyoming	5	0	4	0	....	....	5	7	71	68	12,371,100
Total	1434	1444	1098	1079	1796	1338	989	904	3095	2851	903,850,812

PROGRESS OF MAJOR PIPE LINE WORK

THE 88-mile pipe line of the General Pipe Line Company, subsidiary of the General Petroleum Corporation of California, is expected to be completed some time in July, according to present plans of company officials. Macco Robertson and Lang Transportation Company have been named as general contractors. H. C. Price, Inc., has been awarded the contract for electrically welding the line. Orders were placed recently for 8100 tons of 10¾-in. seamless steel pipe; 4100 tons were purchased from the National Steel Tube Company, 3200 tons from Youngstown Sheet and Tube Company, and the balance from Spang-Chalfant Company. The project will involve an expenditure of approximately $1,000,000.

Tying-in at the company's refinery and pumping station at Lebec, the new line will link directly the company's holdings in the San Joaquin Valley with its refinery at Torrance, California, in the Los Angeles Basin.

Company engineers have established a grade that will enable them to transport products from the Lebec plant to Torrance at a normal rate of 40,000 bbl. daily without the necessity of intermediate pumping stations, and with a capacity for the line of 60,000 bbl. daily by employing one electric booster station.

When completed this project will give the General Pipe Line Company a total of 700 miles of main lines, in addition to several hundred miles of gathering lines throughout the various fields in the San Joaquin Valley.

●

The Standard Oil Company of California has completed its 106-mile 12-in. line from San Joaquin Valley fields to tidewater at Estero Bay. Six pumping stations were constructed and ship loading facilities at the Estero marine terminal enlarged. All stations are steam powered and are situated approximately 18 miles apart.

The new line starts at the Rio Bravo pump station in Kern County, between the Kern River and Midway-Sunset fields. New tankage approximating 700,000 bbl. has been provided at the station for concentration of the crude before shipment.

Operating conditions are such that when transporting light crude it will be necessary to operate but three pumping stations, the one at Rio Bravo and two others. The movement of heavy Kern River crude, however, will require the use of all six stations, with the oil being heated before entering the line.

The Estero marine terminal has been given additional facilities. Six tanks having a total capacity of 825,000 bbl. have been constructed, and connected to them is a 22-in. line leading to the shore and thence to an 18-in. submarine line extending 3000 ft. into the ocean. The terminal now can handle two ocean-going tankers simultaneously, loading each at the rate of 15,000 bbl. per hour.

●

The construction of a gas line from the Texas Panhandle to Detroit and St. Louis is still under consideration by federal and state officials. Plans for the proposed line have been outlined to the public works administration and are being studied by the legal division for suggestions in preparation of a PWA loan application to be filed after a state corporation is created to administer the program.

The pipe line proposal was explained to PWA Administrator Harold L. Ickes and the legal division by R. B. Anderson, Texas state tax commissioner, and Scott Gaines, first assistant attorney general.

Upon approval of the state corporation set-up and legality of the bond lease contract, Anderson said a bill would be introduced providing for the creation of a Texas gas conservation corporation. This body would be given authority to buy and sell gas and construct the pipe line.

Cost of the pipe line is estimated by Anderson at $60,000,000 for two lines, one to St. Louis and another to Detroit, and from $40,000,000 to $45,000,000 for a single line to Detroit. He said a 26-in. line would be required to Detroit and a 24-in. line to St. Louis. It would take approximately a year to lay the line.

Anderson's cost estimates contemplate a 20-year loan. If the PWA is continued and the present ratio of 70-30 per cent loan and grant allotments followed, 30 per cent of the allotments might be obtained as a grant that need not be repaid.

Anderson pointed out that construction of the pipe line would serve three great purposes: Conservation of a limited natural resource rapidly being wasted; afford consumers a cheap fuel; and provide widespread employment both directly in laying the pipe line and indirectly in fabricating the steel. In addition he stated that permanent employment would accrue to 300 families in superintending pipe line operations.

●

The B. & M. Construction Company, Oklahoma City, Oklahoma, has been awarded the general contracting job for construction of the Cimarron Valley Pipe Line Company's 6-in. gasoline line from Enid, Oklahoma, to Superior, Nebraska. H. C. Price, Inc., Bartlesville, Oklahoma, has been given the contract for electrically welding 120 miles of the line, from Enid to Hutchinson, Kansas. Truman & Smith Construction Company, Eldorado, Kansas, has been awarded the contract for laying the line from Hutchinson to Superior.

The Cimarron Valley Pipe Line Company recently purchased 40 acres of land east of Hutchinson upon which a pumping station will be constructed. Tanks, loading racks for trucks, and track facilities also will be erected on this tract.

The pipe line company laying the 250-mile line is an associate company of the Champlin Refining Company of Enid and gasoline manufactured by the latter concern will be pumped through the facilities.

●

The petition of the receivers for the Missouri-Kansas Pipe Line Company to reorganize the Panhandle Corporation and the Panhandle Eastern Pipe Line Company was denied in Chancery Court at Wilmington, Delaware. In rejecting the petition Chancellor Josiah O. Wolcott declared the Missouri-Kansas receivers would emerge from such reorganization with all interests in the Panhandle Eastern wiped out.

●

The Magnolia Pipe Line Company is having the pipe reconditioned on several portions of its line in Texas. The Mitchell Stewart Construction Company, Dallas, Texas, is the contractor handling the work and crews are now engaged near Corsicana, Bryan, and Luling. Working from those three points toward Beaumont, the line is being reconditioned, coated, and wrapped where needed.

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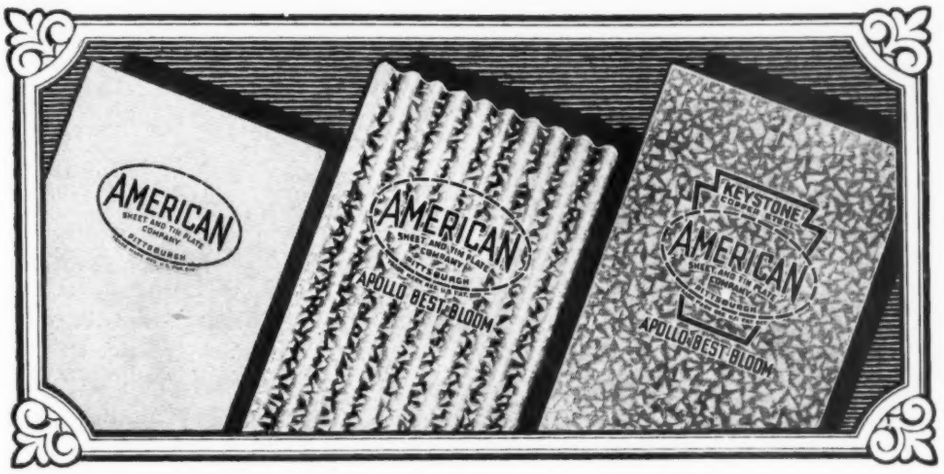

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THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refinery Capacity Operated

Eastern Division, 75.6 per cent **Central Division, 67.3 per cent** **Western Division, 60.5 per cent**

INLAND REFINERIES, Inc., have announced plans to construct a refinery with 1000-bbl. capacity at Pontiac, Michigan. E. G. Guy, formerly of Muskegon, who had many years' experience in Oklahoma and Texas before going to Michigan to build and operate the Old Dutch Refinery, has designed and will be in charge of construction of the Pontiac plant. He has just completed erecting a plant of 2000-bbl. capacity at St. Louis, Michigan, for the McClanahan Refineries, Inc. The Inland refinery will be located on a 13-acre tract between the Grand Trunk Railroad and the Dixie Highway. Guy has been named a director of the company. Officers are: President, Carl L. Skidmore; vice-president, Paul Martin; and secretary-treasurer, Benjamin F. Hall.

●

The Great West Refining Company, recently organized at Regina, Saskatchewan, Canada, has purchased a refinery at Collins, Montana. The equipment will be moved to Yorkton, Saskatchewan. The plant has a capacity of 500 bbl. daily and additional equipment will be installed to increase this to 1000 barrels. W. D. Craig is president of the Great West Refining Company. P. M. Withers is vice-president and will be in charge of the Yorkton plant. Other officers are W. M. Fuller, Regina, secretary; Jacob Kalmkoff, Makrock, and F. O. Wright, Orran, directors.

●

The firm of Dent, Ltd., has been incorporated and purchased a 40-acre site at Burnaby, British Columbia, Canada, upon which a $250,000 refinery will be constructed. Work will start September 1, it is announced.

Many construction and rehabilitation projects are in progress and planned for refineries on the Gulf Coast of Texas. It is reported that The Texas Company will spend a total of $3,000,000 on its plant at Port Arthur, approximately one-third of which sum will be expended on the installation of a solvent refining plant for lubricating oils.

The Pan American Refining Corporation, a subsidiary of the Standard Oil Company of Indiana, will double the capacity of its 30,000-bbl. refinery at Texas City, it is understood. A combination cracking and distillation unit is to be installed.

The plant of the Deepwater Oil Refineries on the Houston ship channel has been leased and will be operated by the Eastern States Petroleum Company of New York City.

The Petroleum Conversion Corporation of New York is contemplating the rehabilitation of its refinery at Texas City, which has been shut down for ten years, making it into a 2000-bbl. capacity plant.

The Gulf Refining Company recently let contracts for 14 new pressure tanks for its Port Arthur refinery, and it is reported that construction work will start soon on a new solvent refining system. In addition the company is planning certain modernization work in its various departments.

The Shell Petroleum Corporation and the Sinclair Refining Company are both reported as contemplating improvements to their plants in Houston, while the Humble Oil and Refining Company at Baytown has been investigating various solvent refining and solvent extraction processes with a view to enlarging its lubricating oil manufacturing department.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks. Week Ending March 23, 1935

A.P.I. Figures
(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Oil Fuel Stocks Thousands of Bbl.
East Coast	100.0	422,000	72.5	17,710	9,894
Appalachian	93.3	105,000	75.0	2,134	810
Ind., Ill., Ky.	94.6	335,000	79.4	9,722	4,322
Okla., Kans., Mo.	83.7	257,000	66.6	5,728	3,946
Inland Texas	47.6	103,000	61.7	1,447	1,883
Texas Gulf	97.7	527,000	89.8	6,720	8,461
La. Gulf	96.4	110,000	67.9	1,466	3,547
No. Louisiana-Ark	83.7	39,000	50.6	275	347
Rocky Mountain	66.7	43,000	67.2	965	750
California	96.9	443,000	53.9	10,704	65,391
TOTALS WEEK:					
March 23, 1935	89.8	2,384,000	69.9	56,871	99,351
March 16, 1935	89.8	2,405,000	70.5	57,018	99,025

●

The Pentagon Refining Company has under construction at Plymouth, Michigan, a refinery that will have a daily capacity of 1500 bbl. of crude.

●

The Malco Refineries, Inc., has installed a late-type agitator that doubles the charging capacity of the plant.

Gel-Cement

Its Use and Application in Drilling Wells

A provision against lost circulation through cavities and fissures, with prevention of caving and heaving formations, and added economy in cementing strings of casing

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles, California

CEMENT offers the best means possible for blocking off cavities and fissures and for confining formations that tend to slough off or heave into the hole. It is not always possible, however, to make a pumpable mixture of cement and water stay where it will be effective. To provide it with a desired consistency that will give it a high angle of repose and confine the water necessary to the mix within the mass of cement formed, a gel-cement can be made by the addition of a specially-treated bentonite that is mixed with the water before making the cement slurry. This gel-cement has been found to stay in place without undue dissipation into extensive fissures and thus has been used as a means for preventing and recovering lost circulation. In addition, it has been found to offer both facility and economy in cementing casing, sidetracking, straightening crooked holes, plugging, sealing off high-pressure water entry, and for special jobs particular to an individual well.

The gel-cement now being used is made by the addition of Aquagel, which consists almost entirely of gel-forming colloidal particles, to the water before it is mixed with the cement to form the slurry. The difference between the slurry thus made and neat cement is clearly indicated in the accompanying photographs. The angle of repose of the gel-cement is about 45 degrees while that of neat cement is approximately five degrees. The effect of this in keeping the cement in place is shown in Figs. 1 and 2. In addition, however, is the advantage offered by gel-cement in confining the water of the mix within the mass and not allowing it to arise to the top as in neat cement where it keeps a drainage outlet open for circulation to pass through even after the cement has set.

Gel-cement was first used in the Barbers Hill field, Texas Gulf Coast, where the overhanging salt dome has necessitated penetration through the limestone cap-rock, then an anhydrite, then the overhanging salt plug, then shale, and then into the producing sand. Since the cap-rock in this field was found in most cases to be badly fissured, the returns while drilling through it would be lost and the fluid level would stand at about one-third the height of the hole. The best method to meet the conditions was found to be the use of neat cement; but this was not entirely satisfactory because the cement would not mass up and stay where it was placed.

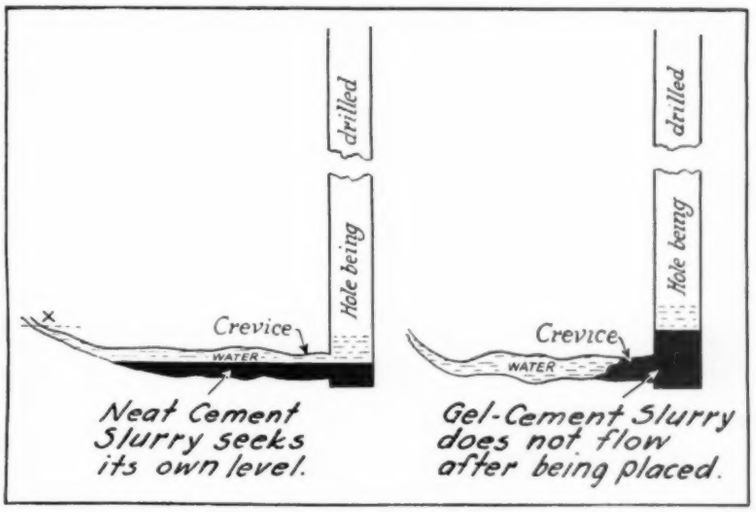


Fig. 1. (Right) Showing difference between neat-cement slurry and gel-cement slurry when placed in well.

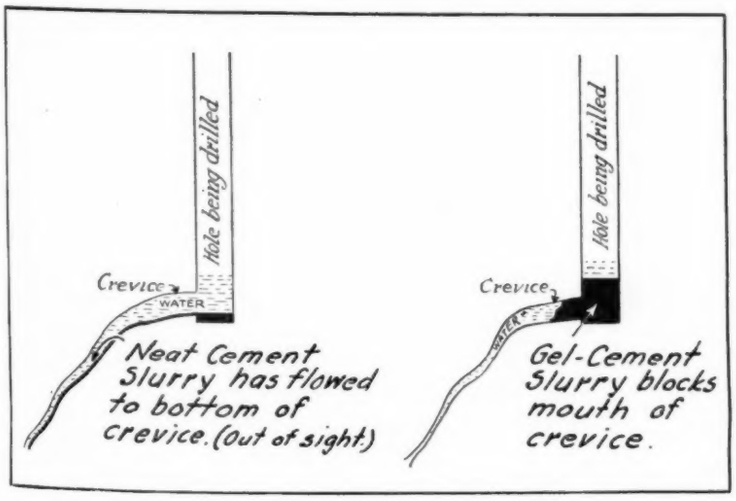


Fig. 2. (Below) How a gel-cement slurry stays in place and produces an effective seal.

The crevices were full of water and the cement, because of its fluid nature, flowed out into the cavities to seek its own level. It was therefore practically necessary to fill up the entire cavity with the slurry before any benefit could be derived from its use. With the introduction of gel-cement, the action was probably somewhat similar to that shown in Fig. 1. The formation, of course, was

broken up by many and various-sized fissures but the result in general can be visualized from the illustration here given. The amount of cement required was greatly reduced and averaged perhaps 50 per cent. In addition, the time required was considerably less when using the gel-cement than when using neat cement.

The strength of cement varies almost entirely with the water-cement ratio. The use of Aquagel in making gel-cement seems to have little effect on the strength up to a percentage as great as five or six per cent by weight. Since gel-cement has been used by other industries for years, sufficient data have been collected to compile recommended amounts of the colloidal material for the various water-cement ratios that are necessary for different applications. The recommended quantity is shown in Fig. 3 although the amounts indicated have frequently been exceeded. Since high water-cement ratios decrease the strength of the set cement, however, it is probably not advisable to use more than three lb. of the colloidal material per sack of cement in making up gel-cement for use in setting casing.

All points on the curve shown in Fig. 3 produce gel-cements of practically the same consistency and having an angle of repose of approximately 45 degrees. With any given water-cement ratio, the more gel used the greater will be the consistency and the angle of repose. The consistency attending the amounts recommended will provide a pumpable slurry and, while the slurry may look too thick, there is a considerable lubricating property to gel-cement that aids in its handling.

Use in California

One of the larger oil companies has done considerable field and laboratory work with gel-cement in California and has made the results available for the use of the organization in other sections of the country. Although the main objective was to increase the consistency of the cement, it was found that it prevented contamination by oil and mud in the hole, the homogenous mass acting as a plunger to force the foreign matter ahead of it and at the same time keeping within the mass itself the water content of the mix.

In using gel-cement successfully a number of times in one well to regain lost circulation, the percentage of gel was varied with the rate the circulation was lost. In cases where circulation was lost completely and the hole caved, as much as ten per cent by volume was used. This was mixed at 125 per cent slurry or 2.36 cu. ft. of slurry per sack of cement. The gel material was first mixed with water by the jet method, circulating it through the pumps. This was then circulated through the hopper and the cement added. The resultant mix was as thick as jelly and had to be pushed to the pump suction; but, due to the lubricating properties of the gel-cement, it was as easy to pump as ordinary cement as soon as the pump picked it up.

With this ten per cent mix, twice the volume per sack of cement was attained and the strength was sufficient to plug up the fractures or voids. Two such jobs of 120 cu. ft. each were sufficient to regain circulation and circulation was never again lost at the same points. In cases where circulation was not completely lost, a five per cent mix was used and the slurry cut down to 100 per cent, or two cu. ft. per sack of cement. This provided greater strength.

In plugging back to redrill, the large volume per sack of cement makes gel-cement advantageous. The final job can be done with neat cement or a two per cent gel-cement. Yet in one well where an attempt to sidetrack off neat cement had failed, the hole was later sidetracked after cementing for lost circulation with five per cent gel-cement that had stood only eight hours.

Another company, after failing to whipstock off ordinary cement, was twice successful in whipstocking off four per cent gel-cement. A core of this particular cement showed it to be very hard, homogenous, of fine texture, and with no evidence of contamination. Stringers and crusts were not present above the gel-cement, since the water did not leave the cement during setting.

Contamination Test

Since contamination of the cement with mud or oil used for drilling in one of the greatest causes of poor cement jobs, tests were conducted by the oil company to make a comparison between neat cement and gel-cement when subject to contamination. To make the tests, a 2-in. pipe, three ft. long and notched at the bottom, was centered inside a 4-in.

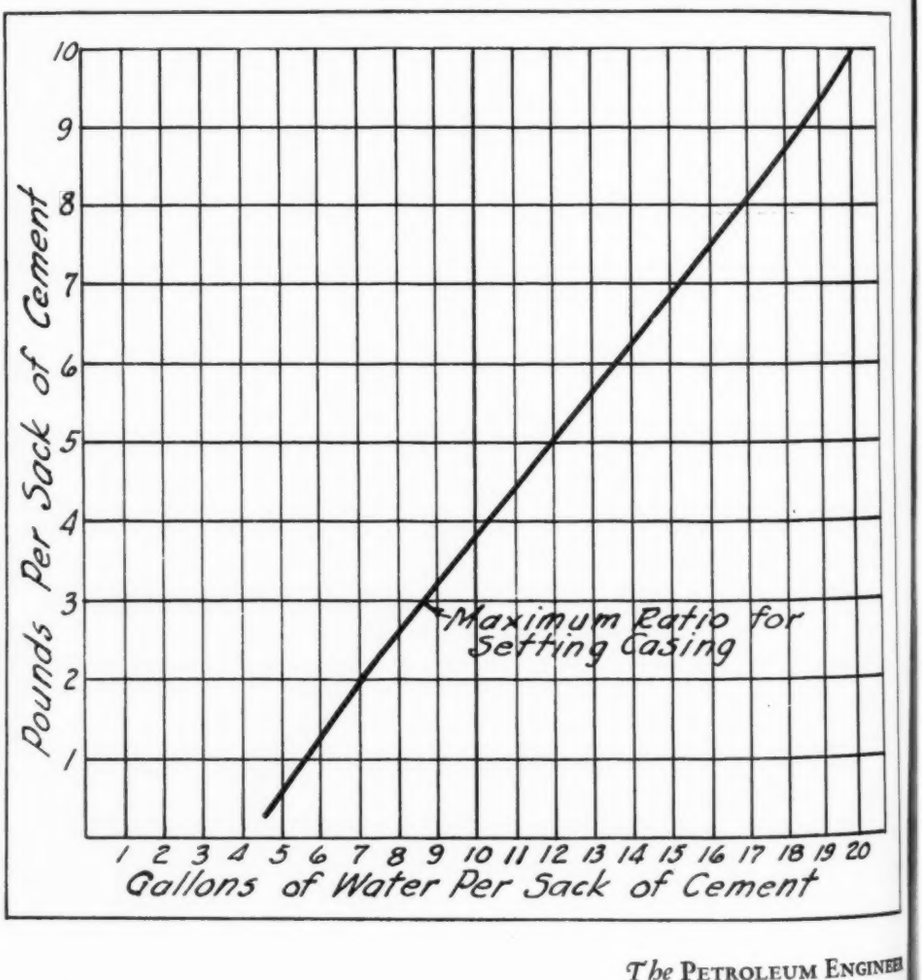
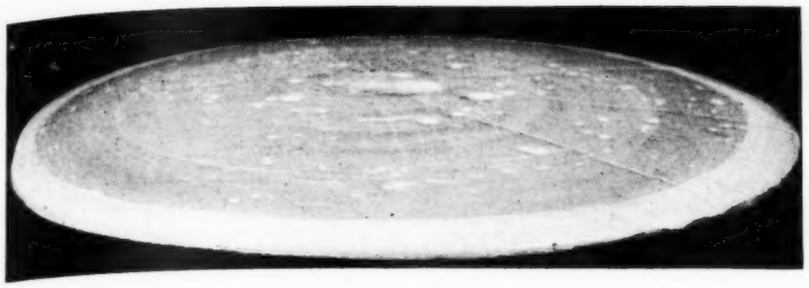


Fig. 3. Chart showing the recommended quantity of Aquagel to be used to produce gel-cements of equal consistencies with ordinary Portland cement.



Slurry of neat Portland cement with water-cement ratio of 5½ gal. water per sack of cement. The neat cement flows freely and has an angle of repose of approximately five degrees.

pipe 1½ ft. long. These pipes were greased inside and out and filled with oily drilling mud. A calculated amount of neat cement, mixed at a 60 per cent slurry and treated with $CaCl_2$, 1.2 deg. Baumé, was poured into the top of the 2-in. pipe and displaced with enough drilling mud to fill the annular space between the two pipes to within three or four inches of the top of the 4-in. and yet leave about six inches of cement in the bottom of the 2-in. pipe. The same operation was repeated with 2½ per cent gel-cement, mixed at 60 per cent slurry, treated with $CaCl_2$, 1.2 deg. Baumé. After 24 hours, the pipes were cut open and the cores removed. The results found were as follows:

Samples taken from bottom—

Straight cement broke easier than the gel-cement.
Gel-cement had larger air holes.
Gel-cement of finer texture.
Cement of darker color (probably damper).

Samples taken from 2-in. pipe—

Neat cement had larger air holes.
Sides of cement core were pitted while sides of gel-cement core were round and smooth.

Samples taken from space between the two pipes—

Broke neat cement by hand but could not break gel-cement by hand.
Neat cement showed traces of oil throughout core; gel-cement did not.

Conclusions (by engineer in charge)—

Gel-cement was harder after 24 hours.
Gel-cement was homogenous while the neat cement was contaminated with the drilling fluid and fractured easily.
Gel-cement filled the hole to its full diameter without pitting.

It was also recommended that further tests be made with both cements to determine their penetration characteristics by using typical oil sand cores under a pressure of 1000 lb. per sq. inch. These should determine: (1) whether gel-cement will penetrate far enough to give a good bind; and (2), whether water is forced out into the sand leaving the cement to mat against the face of the sand. It is felt that since water is held so firmly in gel-cement, this would indicate that the water would be less likely to filter out of gel-cement than it would out of straight cement. Such would be an ideal condition if as much as ⅛ in. penetration can be obtained.

Gel-Cemented Casing

While the amount of colloidal material added to cement must not be in a quantity sufficient to impair the strength of the cement used in setting casing, the volume of gel-cement within the limits is considerably greater than neat cement per sack. This provides an economy that is in addition to the advantage offered by the gel-cement in being uncontaminated by the mud and oil in the hole. Records kept on some of the wells drilled in the Mid-Continent offer some interesting studies in this respect.

In one well drilled with an 11-in. hole to 3695 ft., a string of 7-in. casing was cemented at 3690 feet. Making due allowances for the conditions existing in the hole, it was calculated that 2250 sacks of cement would be necessary for the job of cementing the 7-in. string with neat cement. By using gel-cement with a slurry weighing 14 lb. per gal. that made a volume of 1.48 cu. ft. per sack of cement, the amount of cement that was used to insure a good job was only 1784 sacks plus 65 sacks of Aquagel.

In setting 3790 ft. of 7-in. casing in 3800 ft. of 11-in. hole in another well, 1608 sacks of cement and 75 sacks of Aquagel were used instead of 2100 sacks that were calculated as necessary if neat cement had been used. Some other examples have been:

400 sacks cement plus 30 sacks Aquagel in place of 690 sacks cement
348 sacks cement plus 25 sacks Aquagel in place of 692 sacks cement
460 sacks cement plus 25 sacks Aquagel in place of 800 sacks cement

There will probably be many individual problems that can be met by the use of gel-cement. In one well, for instance, a gas-charged water sand was encountered that required the use of weighted mud. At a short distance below this, there was another coarse sand that robbed the mud stream of considerable fluid. A gel-cement with a water-cement ratio of 14 gal. of water per sack of cement was made up that weighed the same as the circulating mud used. This slurry was pumped into the hole, replacing part of the drilling mud; and before it had all been used, the formation took no more slurry. After 12 hours, the plug was drilled up and no further loss of fluid occurred. The gel-cement in this case furnished ample weight to confine the pressure zone during operations and evidently penetrated the lost circulation zone sufficiently to seal it off.

The availability of weight that is offered may be used to advantage in controlling high-pressure fissured or fractured formations. No reports have yet been received of actual applications of this kind, however, so no data can be offered at the present time.

The success attained in using gel-cement is influenced by the manner of mixing. The colloidal material must be mixed with the water first and the cement added only after this mixture of the gel and water has been thoroughly made.

Slurry of one sack Aquagel to 100 sacks Portland cement and 5½ gal. water per sack of cement. The gel-cement has an angle of repose of 45 deg. and will not flow after it is deposited

Cement Protection of Pipe Lines*

By

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THE inter-refinery pipe line system of the Standard Oil Company of New Jersey consists of nine 8-in. lines running from Bayway Refinery to the Bayonne Refinery in New Jersey, with three of the lines extending on to the Eagle Works in Jersey City. The first line was laid to Bayonne in 1894, four lines were added in 1911, and four more were installed in 1919. Upon leaving Bayway, the route crosses Staten Island Sound, Staten Island, and Newark Bay, thence through the city of Bayonne and on to Jersey City. The total length is approximately 12 miles, the distance from Bayway to Bayonne comprising about two-thirds of the total. For a distance of four miles, pipe lines are laid under water and an additional length of one mile is in salt marsh where the line is flooded by spring tides. On the stretch from Bayonne to Eagle Works the line is above high tide level, but it is for the most part in cinder fill so close to water level that it is subject to corrosion by salt water because of capillary action in the ground. The lines have been constructed entirely of open-hearth lap-welded steel pipe with screw joints, with the exception that in recent years seamless pipe has been used for making all bends, and since 1931 welding has been used instead of screw joints on all major replacement work.

Cement mortar protection, consisting of one part cement to three parts sand, was first used on the inter-refinery pipe lines when the four additonal lines were laid in 1911. Cement mortar installed at that time was placed in a square wooden form with no bottom board. In some cases the thickness of the protection amounted to as much as four or five inches on the top of the pipe, although it was nominally supposed to afford a 2-in. covering. The piping was coated with Parolite before the mortar was applied.

In 1919, the method of applying cement mortar protection was changed. Circular steel forms, giving a 1-in. thickness of the coating, were used and chicken wire reinforcing was applied on bends. Spacers made of strap iron were used inside forms to center the forms on the pipe.

Sometime previous to the use of circular forms, bottom boards were introduced with the square forms and brick or wood spacers were included to hold the pipe off the bottom board. In 1920, wooden forms were again resorted to, this time with 2-in. spacing blocks precast of cement. The last step in improvement of cement mortar protection was to utilize circumferential reinforcing placed every six in. along the pipe. The method of applying this reinforcing was to introduce stirrups made from No. 4 gauge wire shaped like an inverted U. These were pressed into place in the wet mortar by hand immediately after pouring. Throughout this period some type of protection was used between the mortar and the pipe, with the exception of a short period around 1921 when the mortar was applied directly to the bare pipe. Parolite, an oxidized asphalt, was first used, later wax tailings being applied, and today both Ennjay enamel and a product similar to wax tailings are being used.

The results obtained from use of the several types of cement mortar protection here described can be briefly summarized as follows:

Box mortar with no bottom board has been in place in certain locations for as long as 23 years and it is still in fairly good condition. The reason for the long life in these cases was that the line was under paved city streets, and the sub-soil was relatively dry. In other locations leaks occurred at the bottom of the pipe due to the fact that the mortar had not been thoroughly tamped and compacted beneath the pipe. The results obtained with box mortar employing a bottom board in the form were slightly better, but, due to the fact that wood or brick spacers were used, moisture penetrated to the pipe, causing pit holes at these points. Longitudinal cracks in the coating at the sides and at the top also were responsible for perhaps even more failures than the porous spacer blocks. The strap iron spacers, used for a short period in conjunction with the circular forms, also were responsible for many leaks due to corrosion causing the strap iron to crack away from the adjacent coating and expose the pipe at those points. The introduction of spacers made of precast cement successfully solved the problem caused by the use of porous spacers, as the cement blocks are incorporated practically as a homogeneous part of the protective coating. The use of wire stirrups has practically eliminated the occurrence of longitudinal cracks in the mortar coating. A few circumferential cracks can be found, however, in the coatings where this type of reinforcement is used. These cracks have been attributed to the transmission of hot oil. No serious results seem to occur from them, however, as, for the most part, they are hair-line cracks.

In addition to the mortar protection applied in either wooden or steel forms, some of these lines have been protected with neat cement, troweled onto cheesecloth, spirally applied to the pipe so that the resulting coating was about $\frac{3}{16}$-in. thick and contained four layers of cheesecloth. A coating of bituminous material has always been applied under cement protection of this latter type. Thin coatings can be applied in this manner to pipe above the trench and then lowered into the trench without fracturing the cement coating, provided wide leather or canvas slings are used for handling the pipe instead of the ordinary chain slings.

The experience of the Standard Oil Company of New Jersey with these inter-refinery pipe lines leads to the following conclusions:

(1) Cement mortar protection is not entirely satisfactory where it is exposed to the action of salt water. A life of at least ten years can, however, be counted upon when the mortar is properly applied.

(2) Where cement mortar is applied in forms, spacer blocks made of cement should be used, together with some type of reinforcing, which should be at least the equivalent of the stirrups herein described.

(3) Apart from the action of salt water, cement mortar can be expected to render almost perfect protection if good workmanship and careful supervision are given to the whole job, the most important point being careful tamping of the mortar beneath the pipe to eliminate all voids. Proper mixing and curing are essential features common to this, as well as all other, cement mortar or concrete work. In this connection it is interesting to note that certain observers have stated that it is impossible properly to cure a cement mortar coating on a pipe line while the line continues in operation. This is, of course, attributed to the vibration of the line, but, unfortunately, sufficient evidence is not available to state whether the use of the line during the curing period is really a factor of importance or not.

*Presented before the A.P.I. in Dallas under the author's title of "Cement Mortar Protection of Inter-Refinery Pipe Lines (Standard Oil Company of New Jersey)."

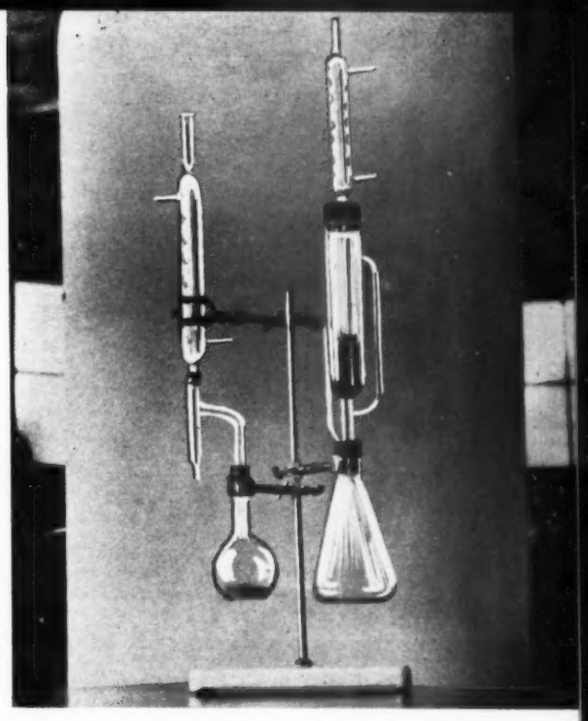


Fig. 1. (Left) A.S.T.M. water determination apparatus. (Right) Soxhlet extractor

Determination of the Oil Content of Sands For Water-Flooding

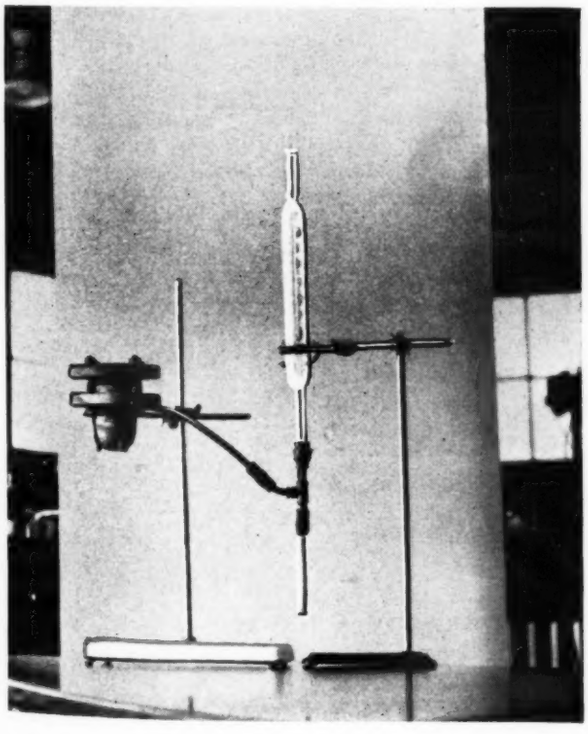
By

W. L. HORNER

Research Engineer,
Forest Oil Corporation, Bradford, Pennsylvania

THE question of how much oil is retained in a petroleum reservoir has always been of interest to producers. This question has often been answered by a solemn guess, or by some equally inadequate approximation based on the production history of the depleted field, assisted by an occasional determination of the porosity of the producing horizon. These methods of estimating the amount of oil that producing methods have failed to reduce to possession are unsatisfactory for water-flooding, and cores of the sand are usually obtained for appraisal purposes. The cores can be tested in the laboratory and the results usually are of assistance in repressuring operations, furnishing definite knowledge of the amount of oil remaining in the oil-bearing formations.

Several methods of testing cores of the reservoir sand for their saturation and oil content have been developed. The writer has had considerable experience with these methods, and it might be of interest to offer a description and some discussion of these various tests:



1. Heating and weighing
2. Extraction methods
   a. Weighing, extracting water, and heating
   b. Extracting oil, measuring water, and weighing
   c. Colorimetric extraction
   d. Extraction and separation of solvent
3. Retort distillation assay

The first method of heating and weighing the rock sample consists simply of brushing the dirt from one or two walnut-sized pieces of the sample and weighing them on a balance. These chunks can be supported on a tripod by a piece of wire gauze and heated until no more vapor is given off, or until they are nearly red hot. The sample may then be cooled in a desiccator, weighed again, and found now to weigh less than before it was heated, because the heat has driven off the oil and water from the pores of the rock, and has evaporated the water of crystallization and carbon dioxide from the rock minerals.

With his method, the oil content is calculated by assuming that all the loss in weight represents evaporated oil:

$$\text{Bbl. per acre foot} = 77.8 \times \text{per cent loss of weight on heating} \times \frac{\text{Sp. gr. of the rock}}{\text{Sp. gr. of the oil}}$$

This procedure gives results that are high and obviously misleading, but nevertheless many such tests have been made and accepted.

A simple refinement of making an allowance for the weight of water boiled off with the oil would make this method of some value. A method for the determination of the water content is borrowed from the A.S.T.M. procedure for the determination of water content of petroleum products. A piece of the core is broken to small bits, weighed and placed in a flask partly filled with toluene or naphtha, and on prolonged boiling the water collects in a special tube placed below the reflux condenser (Fig. 1). The water is thus measured directly, and if its percentage of amount is subtracted from the percentage loss in weight on ignition, the remainder should be the percentage of oil in the rock.

However, in these gravimetric methods there are losses and errors due to the inclusion of water of crystallization of the rock in the loss by heating, and to the loss of fragments of the rock in handling. Some geologists use a method of determining the total water and oil content by extraction

Fig. 2. Retort assay unit

so that these errors are lessened. Several small pieces of the rock are placed in a porous extraction thimble and weighed before and after being extracted by carbon tetrachloride in a common Soxhlet extractor (Fig. 1). A sample calculation by this method would be:

Loss of weight of rock on extraction	3.0 grams
Weight of rock	30.0 grams
Per cent loss of weight by extraction	10.0
Volume of water found in sample	1.0 ml.
Weight of rock	20.0 grams
Per cent water by weight	5.0
Per cent oil by weight	5.0
Specific gravity of the rock	2.0
Specific gravity of the oil	.8

$$\text{Oil content} = (77.8)\ (5.0)\left(\frac{2.0}{.8}\right) = 972 \text{ bbl. per acre per foot.}$$

The three methods described above are all indirect, inasmuch as they weigh certain losses in relatively small samples of rock. These methods involving losses in weight are liable to cause large errors in the final answer, because errors accumulate in each step. Silt and fragments are always lost in extracting, and the water present is partly dissolved in the solvent fluid that extracts the oil. These faults are not easily compensated for, and each throws the calculated oil content higher than it really should be.

Any method of quantitative analysis that is based on extraction is liable to be in error, more especially when the samples are not of uniformly high permeability. Chemical changes can affect the results, especially when solvents other than hydrocarbons are used. The chief objection to extraction methods is that equilibrium is not always obtainable because of the slow diffusion rates within these pores. Continued extraction for several hours is often assumed to be satisfactory, yet it has been found that samples extracted for days often yield more discoloration from oil if soaked in clean solvent for a few hours. Regardless of whether the oil extracted is measured by direct or indirect methods, the errors are always present.

Considerable work was done in the laboratory of the Forest Oil Corporation more than two years ago in an effort to use the colorimetric method of estimating the quantity of extracted oil. This method was suggested by Norman C. Maxwell of the Crew-Levick Company, and was well suited for routine work because a considerable portion of each core is extracted in preparing samples for permeability and porosity tests. A colorimetric method requires the use of clean solvent in the Soxhlet flask for each extraction and this solvent becomes colored brown by the extracted oil. By comparison with standards, the degree of color is identified as representing so much oil dissolved in a unit volume of the solvent. The volume of oil removed from the rock is calculated from the comparison by allowing for the volume of solvent that has been colored to the observed intensity.

$$\text{ml. of oil extracted} = \text{ml. solvent} \times \text{ml. of oil per ml. of matched standard}$$

$$\text{Oil content of rock in bbl./acre foot} = 7780\,\frac{\text{ml. oil extracted}}{\text{ml. rock in sample}}$$

Results obtained from the use of the colorimetric method should not be considered very accurate because of some inherent faults that are difficult to correct. Extraction does not remove all the color, and deterioration of the coloring matter extracted is unavoidable. The color of carbon tetrachloride solution of crude oil "goes off" color in storage and changes while boiling in the extractor flask. The most serious limitation of this method is that in most fields the oil from different layers of rock have different intensities of color when diluted. This is especially noticeable in fields where repressuring by air has oxidized some of the oil in the most permeable streaks, and has rendered the oil darker than the average oil produced from the well. Moreover, an occasional streak or layer of relatively non-volatile bitumen could impart a deeper color to the solvent and its presence would add to the uncertainty of deriving sound results from colorimetric methods.

Samples from the most permeable layers of oil sand can be denuded of the major portion of their oil by boiling or extracting the samples in solvent. This oil can be roughly separated from the solvent by evaporation. Geologists have long used chloroform or ether to leach oil from drill cuttings and upon evaporation of the solution on white cloth or filter paper the discoloration could be attributed to the presence of oil. Evaporation in a glass dish leaves the heavier fractions of the oil visible. By taking a large sample of rock for extraction a larger quantity of oil is removed by extraction and this oil can be directly measured after evaporation of the solvent. Alcohols can be used as solvents for the oil and water in oil sands. Alcohol solvents can be removed from the oil-alcohol mixture by adding water and shaking the mixture. On standing the mixture separates into two layers, alcohol in water on the bottom and crude oil on top.

These methods of separating the oil from the solvent are practical and might be further developed so as to give more accurate results.

It is apparent that much work, and perhaps luck, is needed to obtain

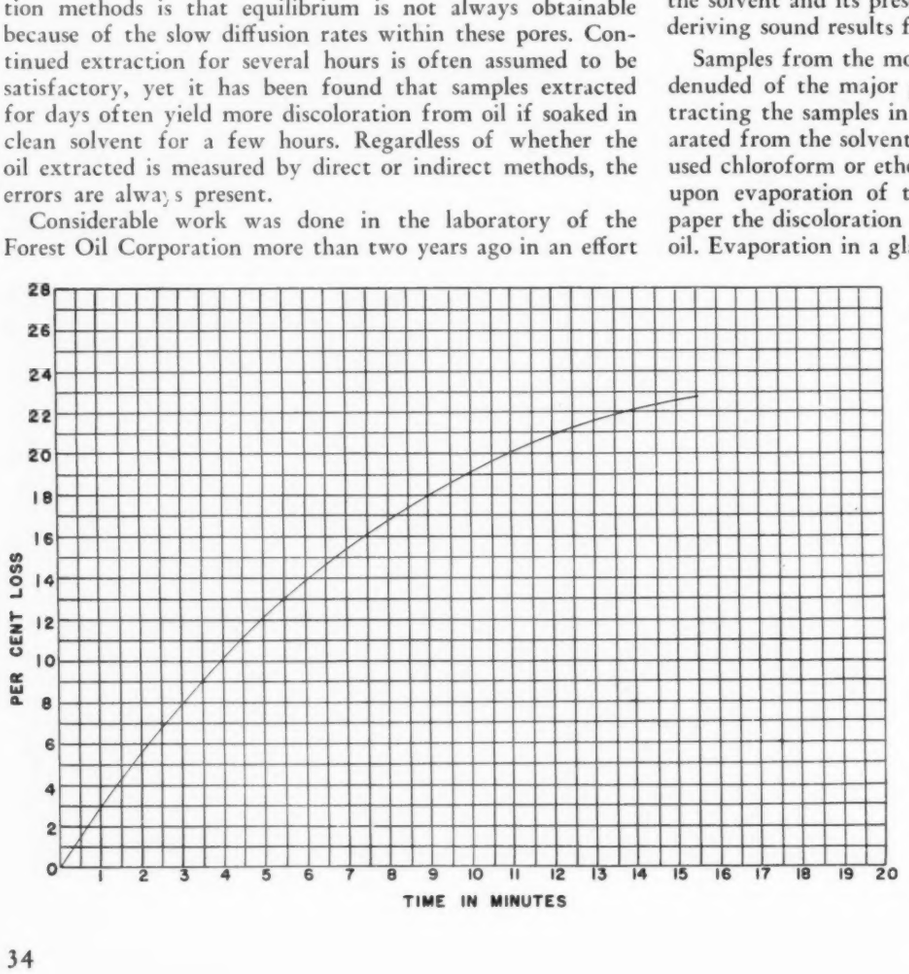


Fig. 3. Evaporation from crushed sample of oil sand

satisfactory results from the methods mentioned in the foregoing discussion. It has been the writer's experience that regardless of the refinements applied to these methods, none of them is satisfactory for core analysis incident to the requirements of water flooding, and the use of retorts is preferable.

The retort method is rapid and direct, and it is the only one giving results that correlate accurately with recovery figures in water-flooding. It shows the water content of the sand and is the most practical system that is in common use. The writer is indebted to Dr. C. R. Fettke[1] of Carnegie Institute of Technology, who published a paper in which he gave results of retort tests on oil sands. Modern routine testing of oil sands requires a somewhat sturdier apparatus than was used in this early work, and the writer's equipment is made with this requirement in mind. Each unit (Fig. 2) of the retort distillation battery consists of a cast-iron mercury retort of about one-half pint capacity supplied with a flat steel lid sawed from a round bar. This lid seats on the french type ring gasket, and is held in place by a blind 2-in. cast iron flange bolted by four bolts to another blind flange, cut and milled to seat against the under side of the retort flange. This clamping device is made from stock parts. The heat used will not warp the flanges very much, and instead damages chiefly the inexpensive brass nuts on the four flange bolts. A 10-in. delivery tube of ⅛-in. iron pipe is welded into a tap in the side of the retort. This tube makes a butt to butt joint with a nipple bushed into a quarter-inch brass tee, and is held against the nipple by a rubber tubing joint. The tee is connected directly to a vertical glass condenser through a one-quarter by half-inch reducer in which a rubber stopper is screwed for the purpose. A home-made receiving tube of half-inch Pyrex glass is attached to the quarter-inch nipple in the lower end of the tee, and is held in place by a short piece of half-inch rubber tubing.

The three joints are leak-proof and flexible so that no breakage occurs; and during the blast heating the rubber over the delivery tube joint is protected from the heat with a wet cloth. The blast burner is simply a high-temperature natural gas burner with the orifice opened to the proper degree to give a turbulent flame when fully turned on. To make a test, a core chunk is removed from its can or jar, and wiped off. A permeability sample and a piece for subsequent porosity tests are fractured off, and the rest of the pieces are broken up and stuffed into the clean retort. The lid faces are polished with emery cloth, the fresh gasket is coated with shellac and the lid is clamped down. The retort is then connected to the condenser and receiving tube, which have been swabbed clean, and the heat is applied for three hours or until no more fluid is driven off at red heat. The recovered fluids are then measured and when the contents of the retort have cooled sufficiently, the rock volume is measured by liquid displacement and the oil content can be calculated.

In any kind of retort device there are losses of oil and water, due for the most part to simple causes, but these losses must be understood and suitable adjustments or corrections made. The curve (Fig. 3) for per cent evaporation of Bradford crude oil in a piece of sand plotted against time, shows that there is an appreciable evaporation loss in preparing a sample for distillation in the retort. If three minutes are required to break the core biscuit into small pieces and cover the pieces in the retort, it is apparent from this curve that a loss of nearly ten per cent could have occurred before the distillation began. A plot of the results of a series of blank tests (Fig. 4) shows the amount recovered as condensate for various amounts of oil charged to the retort. This curve shows a constant percentage (four per cent) distillation loss and 0.6 ml. of holdup. Apparently a constant percentage of the oil charged is lost as vapor and coke, and a constant amount is left adhering to the inside of the apparatus as holdup.

The calculations are made as in the other methods, except that the loss corrections are applied. A core sample from a point ten ft. in the sand in the central part of the Bradford field showed:

Oil recovered, volume - - - - - - - - 6.4 ml.
Rock sample, volume - - - - - - - - 140.0 ml.
Apparent content, bbl. per acre foot:

$$(7780)\frac{(6.4)}{140} = 355$$

Correcting for loss and holdup:

$$(9200)\frac{(6.4 + 0.6)}{140} = 460 \text{ bbl. per acre foot.}$$

All the above-described methods have been tried by the writer and others in Bradford. The retort method is now used on all the cores taken in the Bradford field by consultants and operating companies, and is to the writer's mind the best available method.

On the whole we know very little about the amount of oil retained in our fields but it is probable that the best way to find out is to core the formation and test it in the laboratory. The retort method is the most rapid and is accurate because the operations are few, the samples can be large and the results meet the test of field production practice.

Grateful acknowledgment is due Mr. K. B. Nowels for editorial suggestions and for taking the accompanying photographs. The writer also wishes to express his appreciation to Mr. Forest D. Dorn and Mr. R. J. Brennan of the Forest Oil Corporation for their kind permission to publish this paper.

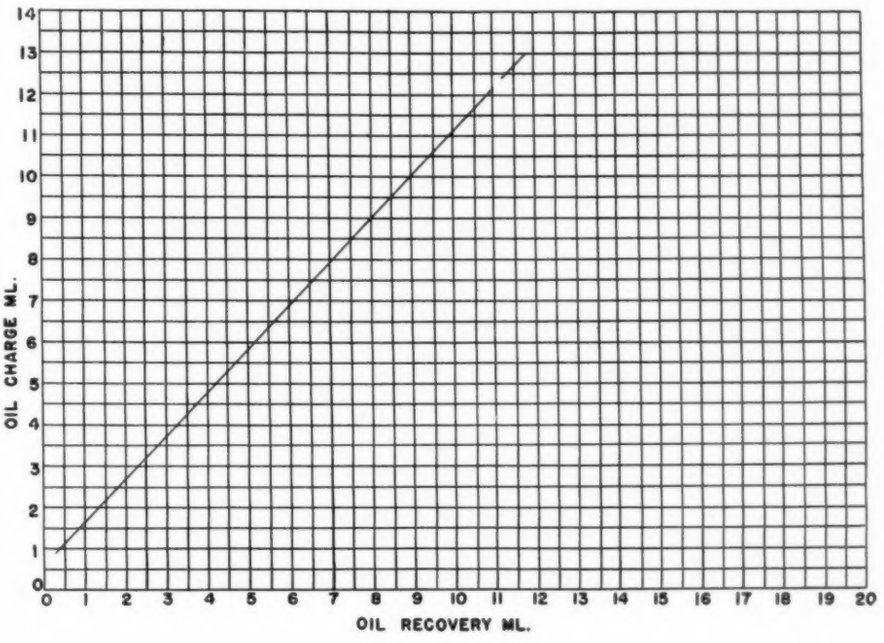
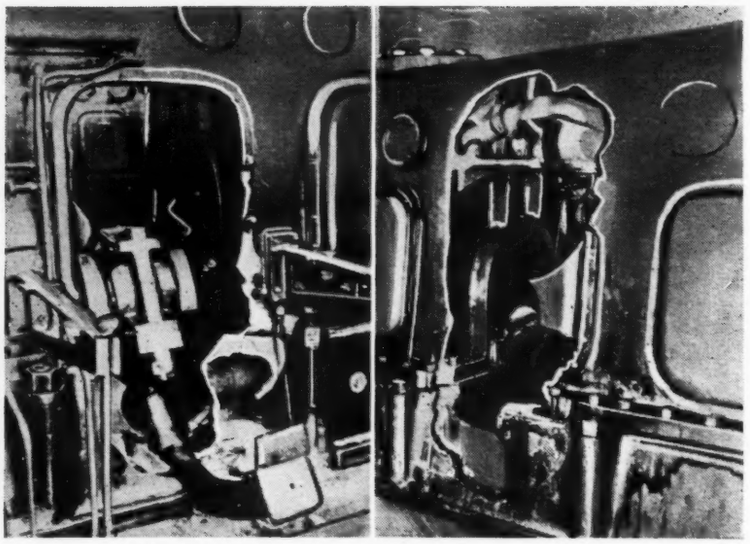


Fig. 4. Retort recovery curve

[1] "Core Studies of the Second Sand of the Venango Group from Oil City, Pa." by C. A. Fettke—A.I.M.E. Pet. Dev. & Tech. in 1926, p. 228.



A 1250-hp. engine wrecked by connecting rod failure at piston

By

SAM MONROE

District Machinist
Stanolind Pipe Line Company

Sounds and Knocks in Diesel Engines

DIFFERENT factors influence the operation and maximum service of the working parts of the Diesel engine. In former articles[1] the writer has discussed problems of heat control and cylinder pressures. As an aid in overcoming these problems there are instruments with which we can measure and determine certain conditions while the engine is in operation.

Some problems of operation arise upon which the operator has to rely on other means for detecting trouble. Among those are the troubles disclosed by the observance of sound while the engine is running. It is with this phase of engine operation that this article is chiefly concerned.

Engine knocks, vibrations, and other troubles may be detected by the sound of the engine while in operation. The engineer must depend largely upon his intuition and experience, to determine, as nearly as possible, defective operation and the source of knocks by means of sound. When the engine is shut down for repairs, observation and measurements can be made of those working parts where the trouble is likely to be, so that the knocks may be definitely determined and corrected. The cause of the trouble will almost always be found either in mechanical mis-alignment and maladjustment of the working parts or in the improper control of cylinder pressures. Quite often it is a matter of correcting conditions both mechanically and in the combustion, which is an involved problem. A proper solution in the opinion of the writer requires that those responsible for the operation of a Diesel engine must first be convinced that a knock or mechanical sound can be quieted if the proper methods and skill are exercised.

The air-injection full-Diesel compression type engine is so designed that the mechanical and combustion elements contributing to engine noises can be controlled when the correct methods of adjustment are understood and

[1] "Valve Efficiencies Are Maintained by Observing Diesel Principles," by Sam Monroe—*The Petroleum Engineer*, March, 1933.

[1] "Problems of Heat Control in Diesel Engine Operation," by Sam Monroe—*The Petroleum Engineer*, March, 1934.

[1] "Avoiding Operating Troubles in Air Injection Compressors of Diesel Engines," by Sam Monroe—*The Petroleum Engineer*, April, 1934.

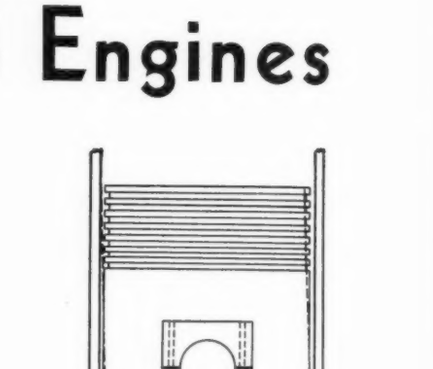


FIG. 1. Dotted lines indicate how friction will deflect the connecting rod, and in turn deflect the piston against the cylinder walls, resulting in a whip, or knock. To correct this condition bearings should be cleared of jaw bind, as indicated

executed by those responsible for operation. There is no better barometer of an engine's condition, and incidentally the ability of the men responsible for its operation, than the noises it makes, or does not make. Certain factors contributing to a noisy engine may sometimes be overlooked by the engine builder; but the operating engineer is making a mistake if, on this account, he charges a noise to a characteristic knock.

Methods that have obtained successful results in recognizing and correcting the source of knocks will be described. First let us consider the two connecting-rod bearings on the conventional trunk type piston. Acting and counteracting in the direction of engine rotation, these bearings, if not properly scraped and fitted, will, as a result of friction, bend the connecting rod and, in turn, deflect the piston against the cylinder walls, resulting in a whip, or knock, and consequently a noisy-running engine (See Fig. 1). Closely interrelated is the behavior of cylinder pressures when at, or near, their maximum. If there are errors in machine work, and mis-alignment of parts that may cause rod deflection, the knock will occur at the instant the greatest working pressures are exerted. It is reasonable, therefore, to assume that if better control of pressures reduce cylinder noise, there also is likely to exist a need for the elimination of deflection. Emphasis is placed upon this fact as a warning against being single-tracked in seeking a clue to the cause to the extent that only a part of the trouble is cleared up. It is advisable to check thoroughly both the cylinder pressures and mechanical factors that affect rod alignment with the cylinder.

Deflection caused by friction can be corrected if the jaws of the bearings are cleared until there remains but 50 per cent of the bearing surface where it comes in contact in the direction of force exerted by the piston. This will increase rather than detract from, as is commonly supposed, the effective and dependable lubrication of bearings and reduce friction to such an extent that noise from this source will be eliminated.

Considering the problem from another angle, that of parallel alignment with wristpin and crankpin bearings, here, in the writer's opinion, is the one factor that contributes most to engine knocks. (See Fig. 2.) When this condition exists then, indeed, the intuition and experience of the engineer must be relied upon to solve the difficulty, for the trouble invariably is the result of faulty machine work on the bearings. There are from 30 to 40 machining operations that can affect and contribute to rod deflection and result in what is commonly assumed to be a "characteristic" piston and bearing knock.

The old practice of shop-craft, that of correcting and measuring bearings to a specified measurement, is more responsible than any other one factor for this problem being so difficult of solution. The bearing should be scraped and fitted in such a manner that the connecting rod is never deflected or in a strain at any point on the radius of the crank. Within the knowledge of the writer, this is the only satisfactory rule for the repairman to follow. If, however, by means of certain measurements or research, corrections can be made by shifting the cylinder or crankshaft they are, of course, advisable. The writer assumes in this statement that all ordinary methods of shop-craft have been employed and that the "characteristic" knock is still there. It is then better for the person making the repairs to fit the bearing in a manner that will give the desired result, for it is one thing to assume perfection in engine-building, and quite another to accomplish it.

Care should be exercised to assure that lateral clearance in the crankshaft is kept adjusted to a minimum. When making adjustments on the thrust bearings it is important to keep cranks in correct alignment with the cylinders. Main journals should be kept at a close-running clearance, so that crankshaft deflection is reduced to a minimum. Quite often because of failure to observe one or more of the principles here outlined, noisy and troublesome cylinder conditions have resulted and have made it necessary to install new pistons and liners. The condition might have been corrected without such expensive repairs by closer observance of the factors influencing connecting rod deflection.

For those operators having the problem of a noisy running engine, it will be well to make a study of the manner in which the crankpin wear occurs. In extreme cases, the crankpin wear will be greatest near the web of the crank or outside the bearing. In old engines it sometimes will be found that the crankpin is actually worn low at these two points. In the case of shafts that have not been used a sufficient length of time to develop this wear, it can be detected by the color on the pin, which is brighter where the bearing contact is greatest. When this particular condition is observed it is evident that either an error has been made in engine construction or assembly, or errors have been allowed to develop after the engine was put into operation. It is, of course, proper to correct these errors when possible. Virtually always some errors can be corrected by the mechanic while making local repairs. There are other errors, however, that for practical reasons cannot be remedied. One of these will be indicated by the color of the wearing point on the crankpin. Within reasonable limits, this error can be compensated by relieving the jaw of the bearing with a scraper at its point of contact with the pin.

Connecting-rod deflection is a major cause of one of the most dangerous conditions experienced in Diesel engine operation. Rod deflection exerts a strain on the crankpin bolts and on the eye of the rod, resulting in crystallization and failure of these vital parts, which, under normal operation, experience little stress. When rod deflection occurs, strain is exerted at the

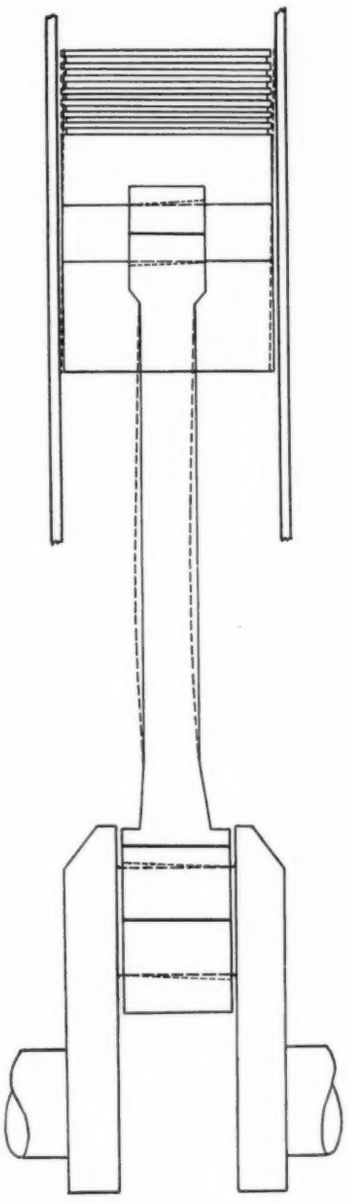


FIG. 2. Illustrating a condition caused by an error in rod bearing alignment, or by faulty machine work on the engine. Between 30 and 40 machine jobs can effect rod deflection and result in a piston or bearing knock. Dotted lines indicate the direction of the deflection

points just mentioned and, in time, is likely to rupture one or more of these parts, causing the connecting rod to loosen and wreck the crankcase of the engine. If the facts were always fully known, they doubtless would show that rod deflection is a contributing factor in a large number of crankshaft failures.

When failures of this kind occur, the causes of the failure should be ascertained and the facts made available. This information would be of invaluable benefit to others in avoiding similar failures. There is also the safety feature to consider. Connecting-rod deflection and the failure of other working parts may lead to a disastrous wreck of machinery and result in serious injury to those employed in its operation.

Crankshaft failures have been greatly reduced during the last few years by correcting deflection at four positions of the crank and scraping bearings. To those familiar with these progressive methods, the value of employing them where connecting-rod deflection is concerned, readily can be seen.

Sound or knocks are usually a good indicator or signal of an engine's distress. If the operator in charge of an engine does not heed these warnings of danger, someone will be compelled to pay in full for the neglect.

Useful Refinery Steam Chart » »

What Diameter? What Pressure? How Many Pounds of Steam?

By
W. F. SCHAPHORST

THIS chart answers all these questions. It will be found very useful for making calculations regarding steam flow, steam pressure, and diameter of opening or diameter of short pipe for given conditions where there is at least 60 per cent pressure-drop through the opening.

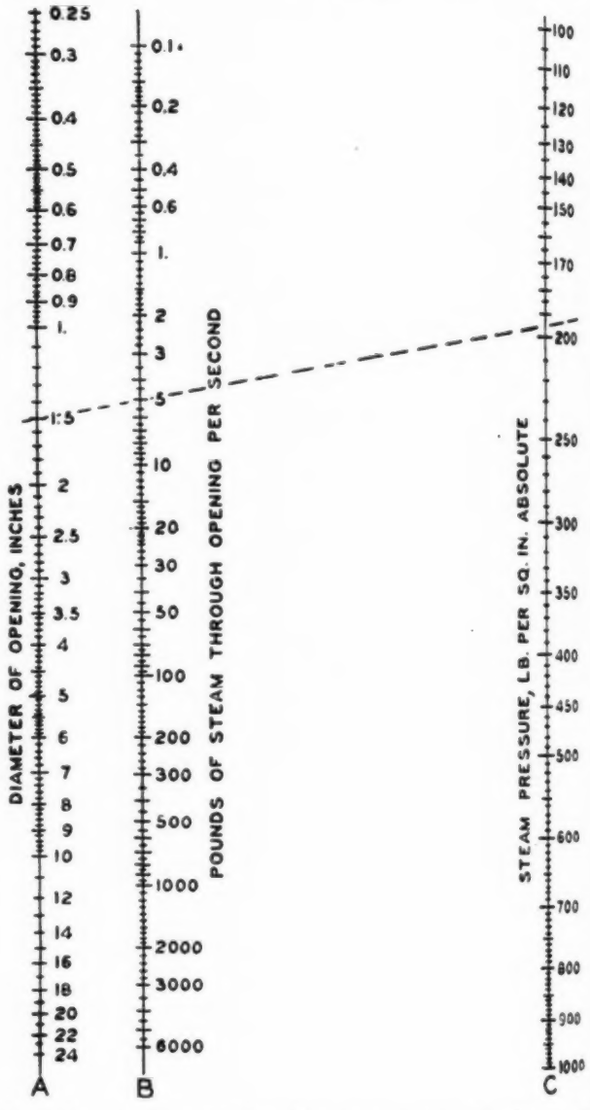
For example, if a steam pressure of 195 lb. per sq. in. absolute is carried, and it is estimated that it will take five lb. of steam per second to handle a given task in the refinery or to heat a given building, the question is, "What must be the diameter of opening or short pipe to permit five lb. of steam to pass into the machine or heating coils per second?"

A heating problem is a good one to use because it usually involves considerable pressure-drop. Very often the pressure-drop is effected through a reducing valve. Where a reducing valve is used this chart comes in handy for determining the size of valve required. In other words, the opening through the reducing valve must be large enough to conduct five lb. of steam from the boiler into the machine or heating coils per second.

The dotted line drawn across the chart shows how easily these problems are solved. Simply run a straight line through 195 lb. per sq in. (column C) and then through the five lb. steam per second (column B) and the answer is 1.5 inches, (column A). That is, the diameter of opening, orifice, or short pipe, whatever you wish to call it, must be at least one and one half inches. Isn't that easy enough?

There are many other places where this simple chart will come in handy. For instance, if you have soot cleaners on your boilers the chart will tell you the number of lb. of steam being used per second by the cleaner in cleaning the boiler tubes. If you burn oil and use a steam jet burner it will give you the number of lb. of steam per second used by the burner, knowing the steam pressure and the diameter of opening. If there is a hole in a pipe, fitting, or elsewhere, and steam is leaking out into the atmosphere, the chart will instantly tell you the number of lb. of steam that are lost per second and will enable you quickly to compute the loss in dollars per week, month, or year. Steam leaks usually are surprisingly expensive. It will tell you the size of safety valve to use. And so on, indefinitely.

Inversely you can determine the steam pressure that will be required to force any given number of pounds of steam



through any given opening from one-quarter in. diameter to 24 in. diameter. In other words, knowing any two factors in any of the three columns you can immediately determine the unknown factor in the third column. Pressures, as you will note, range all the way from 100 to 1000 lb. per sq. in. absolute.

To convert absolute steam pressure into "gauge pressure," simply subtract 15 lb. from the figure in column C. Thus 195 lb. absolute is equal to 180 lb. gauge; 259 lb. absolute is equal to 235 lb. gauge, and so forth.

By

CHAS J. HOLLAND

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Article 3

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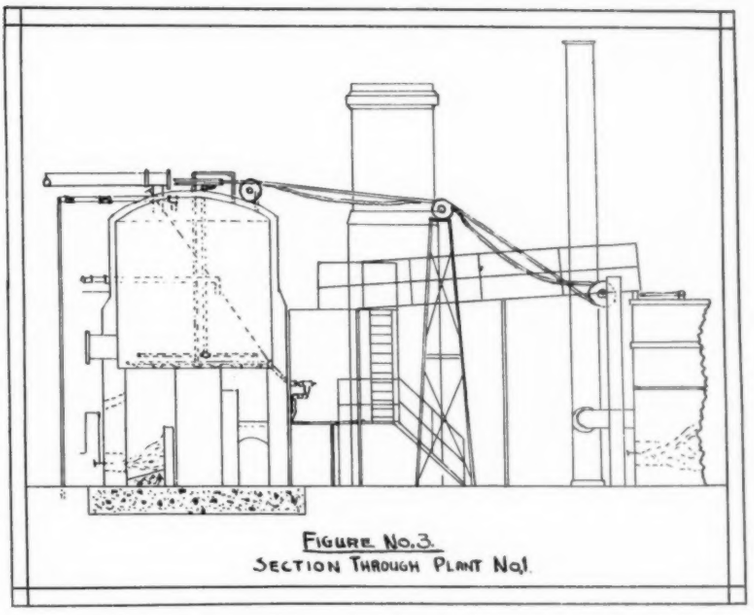


FIGURE NO. 3.
SECTION THROUGH PLANT NO. 1

The Manufacture, Packaging and Shipping of Oxidized Salts

Oxidizing stills, air compressors, and asphalt receiving pans

As mentioned in the second article, in the beginning there were two batteries of eight stills each, then later a third battery was added, giving a total of 24 stills, each ten ft. in diameter by ten ft. high, all set on the same level, seven ft. above ground and arranged for outside oil- or gas-fire heating.

The 4-in. flow-line allowed for gravity flow of the finished asphalts into the receiving pans serving each battery. The details of this system are shown in Fig. 3. In this connection it is worth noting that all valves, cocks, and fittings were of cast iron for 125-lb. maximum pressure service. The flow-line was equipped with ordinary gate valves and where it entered the receiving pans it was shut on or off with asbestos-packed stop cocks.

Charging asphaltum oil of 12 to 14 Bé gravity, at a temperature of 200 deg. fahr., a battery of stills operated at the following temperatures:

Still No.	*Still Temperatures*
1	300-350°F.
2	350-400°F.
3	400-500°F.
4	570°F. Maximum
5	570°F. Maximum
6	570°F. Maximum
7	570°F. Maximum
8	570°F. Maximum

Though air (and occasionally some steam) was used in all eight, it was necessary to fire rather rapidly the first three stills in order to bring the charge up to oxidizing temperatures. It was seldom necessary to do any firing under the other five, due to the exothermic heat of the air-oil reaction.

Firing was done occasionally under one or more of them for several reasons. Sometimes abnormal operating conditions made advisable the removal of part or all the air in one or more of the last five stills. At other times due to specification requirements and/or to changes in charging stocks it was found that best results could be had by using steam and little or no air in the last one, two or three stills. When that happened firing was of course necessary to keep up, and sometimes to increase, the temperatures in the still or stills affected. Again, when the time came to pump out one or more stills containing high melting point asphalt for any reason, such as need for cleaning, repairs, or to make an occasional special batch run, at such times some fire-heating was often of advantage. Hence it was that though during normal operating conditions and when producing the regular specification products, little or no fires were required under the last five stills, they were nevertheless all built and equipped for regular oil- or gas-fire heating underneath and on their bottoms only, as shown in Fig. 3.

The three batteries, i.e., the whole 24 stills, produced at the rate of 150 tons of finished asphalts per calendar day, 4,500 tons per month, or 54,000 tons per year. These figures varied somewhat depending upon characteristics of charging stocks and products produced. The higher in gravity and in fixed carbon the charging stock, the higher the capacity rate for a given melting point product. The higher the melting point required, the lower the capacity rate for a given grade of charging stock. The above figures are based on a Texas crude oil residium of 12.0 Bé. gravity, 3.5 per cent maximum fixed carbon, being oxidized to produce a finished asphalt of 235-245 M.P. Fifty per cent or more of the yearly output was done under approximately these conditions as to charging stock and finished product.

The gravity of the asphaltum oil could not, however, be changed without producing a corresponding change in tests of the asphalt. For example, with other things being equal, asphaltum oil of 9½ to 10½ gravity would make a 240-M.P. asphalt of 16 to 18 penetration and a 260-M.P. product with penetration of 12 to 13. Oil of 12½ to 13½ gravity gave

penetration tests of 20 to 24 and 16 to 17 respectively when producing 240- and 260-M.P. asphalts. Ductility and other tests might also be changed up or down to some extent either by change in gravity of charging stock or by manipulative means in connection with use of air and steam and with temperature variations.

For production of the compressed air required, all 24 stills were adequately served by one 18 by 24 by 18 Laidlow-Dunn-Gordon feather-weight valved simplex air compressor. The air pressure was held at 25 to 30 lb. gauge at the compressor.

Compressed air consumption of Plant No. 1 was at the rate of close to 750 cu. ft. per ton of asphalt produced. This very low consumption is to be accounted for by: (a) the use of mechanical agitation; (b) continuous operation, and (c) use of vertical stills. Where these three conditions do not prevail the air consumption is customarily more than double this amount.

As to still cleaning time and frequency it took one day for cooling and one day for cleaning of stills. Frequency of cleaning depended, of course, upon the grade or grades being manufactured. On the average, stills were cleaned about two times monthly, but this average refers only to the last four stills of each battery where the coke formation (especially the "stalactites" in the roofs of the stills) was the heaviest. The first four stills of each battery could run for a month or longer without necessity for cleaning.

The chief characteristics of the stills as illustrated by calculations on the battery of eight, are shown in the following table:

TABLE 2

Chief Characteristics of Plant No. 1 Oxidizing Stills

Number of stills per battery	8
Dimensions of stills	10 ft. high by 10 ft. diameter
Dimensions of vapor space	4 ft. high by 10 ft. diameter
Dimensions of liquid space	6 ft. high by 10 ft. diameter

	VAPOR SPACE		LIQUID SPACE		TOTAL	
	Cu. ft.	Bbl.	Cu. ft.	Bbl.	Cu. ft.	Bbl.
Per still	314.41	56.1	471.2	84.1	785.6	140.2
Per battery	2,515	449	3770	673	6,285	1122

PER BATTERY

	Per Day	Per Hour
Bbl. of charging stock consumed	321	13.4
Tons of asphalt produced	50	2.08

	Per Still	Per Battery	Per Ton of Asphalt Produced per Battery per Day
Sq. ft. of heating surface	78.5	628	12.6
Sq. ft. of metal used	471.3	3,770	75.4

Actually, the vapor space of 4 ft. high by 10 ft. diameter existed only in the last still. With gravity flow there was, of course, a slightly less and increasingly less vapor space in the preceding seven stills, with the maximum condition of probably 3 ft. by 10 ft. in the first one. For purposes of this series of articles it will be sufficiently accurate to assume 4 ft. by 10 ft. for all stills.

As shown in Fig. 1, there were six asphalt receiving pans, two to each battery. They were of rectangular shape—25 by 30 by 6 ft. divided into two compartments of 25 by 15 by 6 ft. each, and holding 67 tons per compartment. On beginning of operations, the first day each battery would fill one compartment, the second day a second compartment, the third day a third one, and so on. During hot weather, on the third day the drum-filling crew would empty into drums the compartment filled on the first day; the fourth day they would empty the second compartment and so on. Thus there was always available for each battery at least one empty compartment.

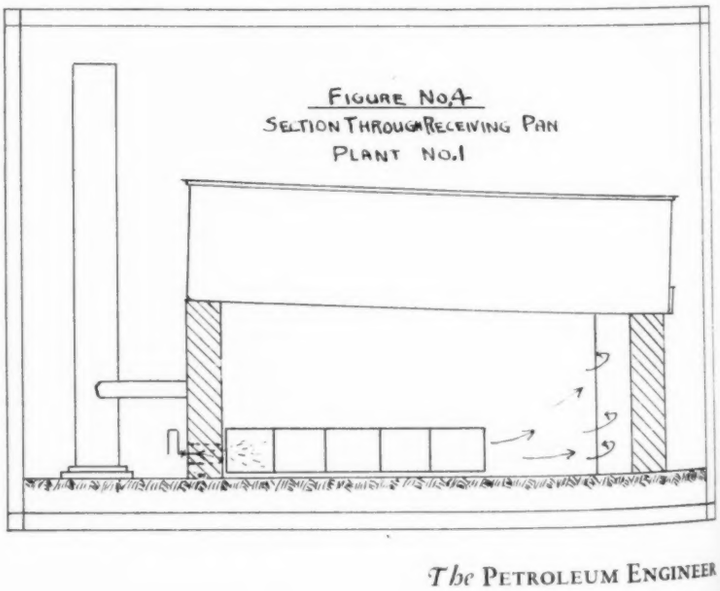
The pans were made of the dimensions given and only six ft. deep for three reasons: first, it was necessary to have a shallow depth, for otherwise the stills would have had to have been set up higher to allow for continuous gravity flow from last still of each battery into the tops of the receiving pans; second, a 30-ft. width gave an efficient spacing of the pans along the length of the drum-filling and cooling shed, from the viewpoint of withdrawal of asphalt into drums in the manner later to be described; and third, receiving pans of long, shallow, rectangular shape permit the accumulation of finished asphalt at the rate of a few inches per hour, whereas a deep, small-diameter, vertically-placed cylindrical tank causes accumulation to be at the rate of many more inches per hour, when comparing tanks and pans of the same volumetric capacity.

This last reason is of vital importance in continuous operation. With almost unavoidable slight changes in the hourly tests of the continuous stream of asphalt flowing into its pan or tank, if the receiver is long and shallow there will be no perceptible difference in the finished product when the pan is filled. But if the receiving vessel is narrow and deep there will be perceptible differences, with consequent complaints from customers of inequality of tests of different drums or barrels from one shipment, taken from one pan or tank.

Fig. 4 shows how the receiving pans were set up on brick foundations and arranged so that when necessary a small oil or gas fire could be carried underneath them. This is another important point about high melting point asphalt receiving vessels, particularly where the continuous principle of operation is to be used. It will be fully discussed in section on Recommendations.

In Plant No. 1 with typical Texas weather conditions, the fires were seldom needed. The problem was usually one of getting and keeping the asphalt in the pans sufficiently cool for filling into packages, particularly when wooden barrels were used. At times, however, there was too much cooling off on the bottoms of the pans though hot enough in the upper sections. When such conditions prevailed a small fire was carried for a few hours before time for drawing into packages. This was particularly true with the 300- to 310-M.P. product, the Grade E variety.

Fig. 5 shows in detail the special type of quick-opening steam-heated valve used on all receiving pans, through which the asphalt was drawn out into packages. It was rectangular in shape and when fully opened was equivalent to a 10-in. gate valve, thus permitting the filling of a drum in 30 seconds or less, depending upon the expertness of the operator. Though this valve was first developed as long ago as 1916-17, the writer has never seen anything better elsewhere at any time, with the qualification that taking into consideration the use of cheap labor and not a mechanized system of handling



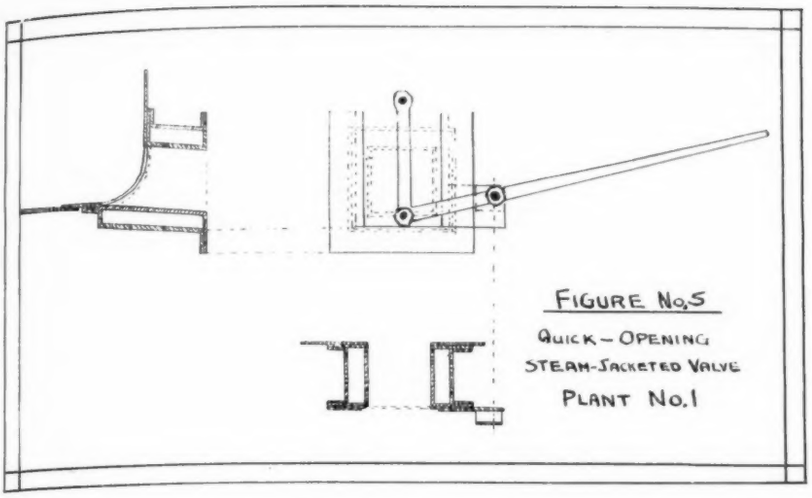


FIGURE No.5
QUICK-OPENING STEAM-JACKETED VALVE PLANT No.1

and filling packages. There will be occasion in section on Recommendations to bring out quite fully the uniqueness and special utility of this valve.

Package-Filling, Cooling, and Storage Sheds

As indicated in Fig. 1, there was available a covered concrete-floored, package-filling and cooling shed 60 ft. wide by 350 ft. long, a total of 21,000 sq. feet. Due to the way packages were filled and cooled it required 5.3 sq. ft. per package. Hence:

$$\frac{21{,}000}{5.3} = 4{,}000 \text{ (approx.)}$$

Four thousand filled drums is equivalent to 800 tons of asphalt. With a production rate of 150 tons per day the total drum-filling and cooling area was equivalent to a little over five days of finished product output. Three days is sufficient for cold weather and low melting point asphalts, but for Texas June, July, and August weather conditions, and for the higher melting point products, a filling and cooling area for five days production is ample, though not too much when remembering the necessity for "topping off."

In addition to the filling and cooling shed there was a second covered shed for filled package storage, 75 ft. wide by 280 ft. long. As shown in Fig. 1, it was separated from the drum-filling and cooling shed by double-tracked standard gauge railway industrial sidings upon which were set out the railway box or gondola cars for loading as shipping orders were received.

Method of Filling Packages

For filling and handling packages the plant was equipped with special type hand trucks or wagonettes. They were designed and perfected by Plant No. 1 men and so far as the writer knows, have never been used elsewhere. Where cheap labor is available and where investment costs must be kept down to a minimum, the Plant No. 1 wagonette represents by far the cheapest, simplest and most practical solution of the package-filling and handling problem.

Fig. 6 shows the essential details of this vehicle. From the sketch it will be readily observed that the wagonette is a very inexpensive affair. Given two agricultural machinery type wheels 31 in. dia. with 2⅜-in. iron tire treads, some short pieces of bar and angle iron, a welder-mechanic can within eight hours time build the wagonette at a total cost of 35 to 40 dollars.

With the No. 1 Plant layout, one man operating one wagonette could fill and set in place for cooling the drums in an average of 5-minute cycles. That is to say, he would take an empty drum, set it in his wagonette, fill it, then haul it to its proper place on the cooling shed floor, and return for another cycle. So that per hour one man would fill and set for cooling an average of 12 drums, or per 8-hour day approximately 100 drums, or 20 tons. Assuming the labor cost at 50 cents per hour this would be at the cost rate of 20 cents per ton of asphalt. Adding to this figure the labor costs of men at the quick-opening valves, for "topping off," for sealing, weighing, and stencilling, the total cost for filling, handling, and shipping out in box cars (assuming 50 cents per hour labor) would be around 40 cents per ton of asphalt produced.

Usually they used ten wagonettes when emptying into drums one compartment of a pan. It will be seen that this operation would require about 2½ hours to complete.

The temperature of the asphalt in the pans when ready for drawing out into drums corresponded to 10 to 15 deg. above the melting point. For example, when packaging grade B (235-245 M.P.) the drawing-out temperature would be about 250 deg. fahrenheit. Asphalt has a high coefficient of expansion when temperature changes are involved. At the No. 1 Plant drums and barrels of one head only were filled and shipped. When a package was cooled and filled within 95 per cent of its capacity it was considered not economical to "top it off," i.e. to return it to the quick-opening pan valve to receive a small additional amount of asphalt.

To avoid as far as possible and with all grades the expensive "topping off" operation and also to strengthen the open end top of the drum while it was being handled in the wagonette, there was used at Plant No. 1 a removable ring, a sort of iron band, four to six in. high. This ring was grooved on its bottom edge so as to set firmly but not too tightly around the top edge of the drum. When thus in place it allowed for filling of drums up to 110-115 per cent capacity with the hot asphalt as drawn from the pans. Before placing rings on drums they were dipped in clay or lime water, which procedure prevented asphalt sticking to the rings and allowed for their easy removal from drums at the end of the first or second day after the asphalt had cooled and contracted down inside the drum proper.

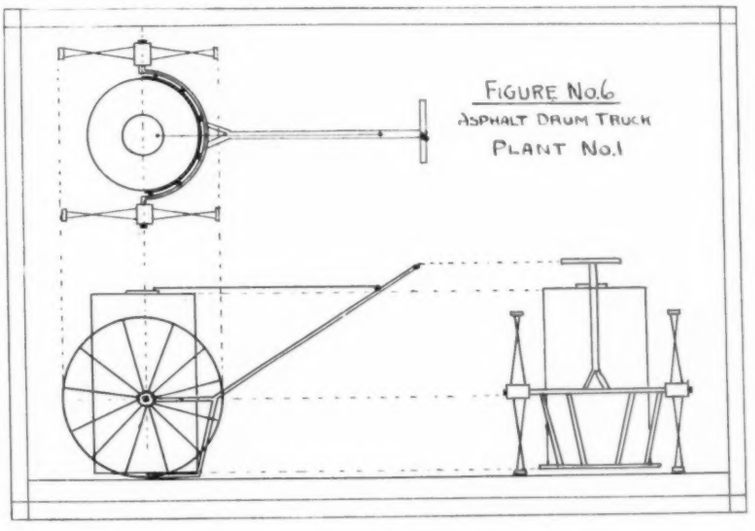


FIGURE No.6
ASPHALT DRUM TRUCK PLANT No.1

Running Packers in Wells Under High Pressure

By H. C. OTIS
Southern States Company, Inc.
Dallas, Texas

THE development of equipment safely to run or pull packers under pressure, regardless of well volume or pressure, is altering the regard with which many operators view the use of packers. Until comparatively recently it was possible to run and pull packers only in wells of very small flow capacity or in wells that could be loaded during the running or pulling operations. Even when being run into very small wells, packers have been known to set prematurely and to be blown out of the well; and wells that have been loaded for the running operation have been known seriously to threaten to unload themselves before the packer had reached the desired depth; too, when the packer is employed to separate two producing horizons, and it is desired to be able to produce from either horizon, running the packer with the well loaded does not leave any way to unload between the casing and tubing to permit the horizon above the packer to produce.

Running packers under pressure, however, does away with the danger of the packer being prematurely set and blown from the well, and makes it possible to land the packer between two producing horizons without killing either. In addition it also removes the necessity for loading with mud or water — always an objectionable operation in a producing well.

During the past year a great many packers have been run under pressure, particularly in West Texas fields. This operation has been performed in wells ranging in depth from the shallow wells in the Yates field to the 8800-ft. wells in the Big Lake field. A brief description of some of the special equipment employed for this work may be of interest.

The snubbers employed are the same as those used when running or pulling tubing alone under pressure. If more than only a few feet of anchor is to be run beneath the packer, the construction of the snubbers should be such as to allow removing the stationary snubbers from around the tubing by taking them apart rather than by "sleeving" them over the top of the tubing. The control heads are the customary ram type used in ordinary tubing pressure operations. The lower of these control heads must of course have an opening wide enough to allow room for passage of the packer, as must also the permanent tubinghead or stuffing box to be left on the well.

This permanent tubinghead must not only have a full opening for free passage of the packer through it, but must also provide means for suspending and packing off the tubing under pressure. Unless the full weight of the string of tubing is to be left on the packer, slips must be landed in the tubinghead bowl after the packer itself has been set and the desired amount of weight "slacked off,"—an operation in a well of more than only a few thousand feet deep that always should be gauged with a weight indicator.

The fact that the opening through the tubinghead must be relatively large to permit passage of the packer in and out of the hole ordinarily precludes using the weight of the tubing to compress the packing element employed in the tubinghead. If, for instance, the opening through the tubinghead—and consequently the area to be packed off—is 6½ in. in diameter and the closed surface pressure of the exposed formation above the packer is 1000 lb. per sq. in., the full weight of more than 5000 ft. of 2½-in. tubing will be required to compress the 6½-in. packing element to an effective seal with the walls of the tubinghead. Unless the well is very deep, it is probable that this much effective weight will not be available after allowing for the weight necessary to maintain the packer in the expanded position. For this reason the ram type control head makes an excellent tubinghead for this purpose, since the rams can be opened wide-open to permit passage of the packer, then, after the packer has been landed and the desired amount of weight has been "slacked off" on it, the rams can be closed around the tubing and the excess weight of the tubing be easily transferred to slips placed above the control head rams.

Shown in the accompanying drawing is another satisfac-

Lubricating packer into well on 2-in. tubing through 8⅝-in. casing, near Amarillo, Texas

tory type of permanent tubinghead for this purpose. The control heads are threaded onto the outside thread of the tubinghead body (1), which has an inside diameter sufficiently large to pass the packer to be run. After the packer has been landed, the packing element (2) is sleeved over the exposed portion of the top joint of the tubing and snubbed under pressure down to, and made up into, the inner threads of the tubinghead body by means of a special landing nipple (not shown.) After this operation is completed, the control heads and the landing nipple are removed. Use of the slips shown is optional, depending on whether or not all the weight of the tubing is to be left on the packer. The reverse operation makes it possible, at a later date, if it is desired to pull the packer under pressure, to thread control heads again on the outside thread of the tubinghead body and remove the slip and packing element.

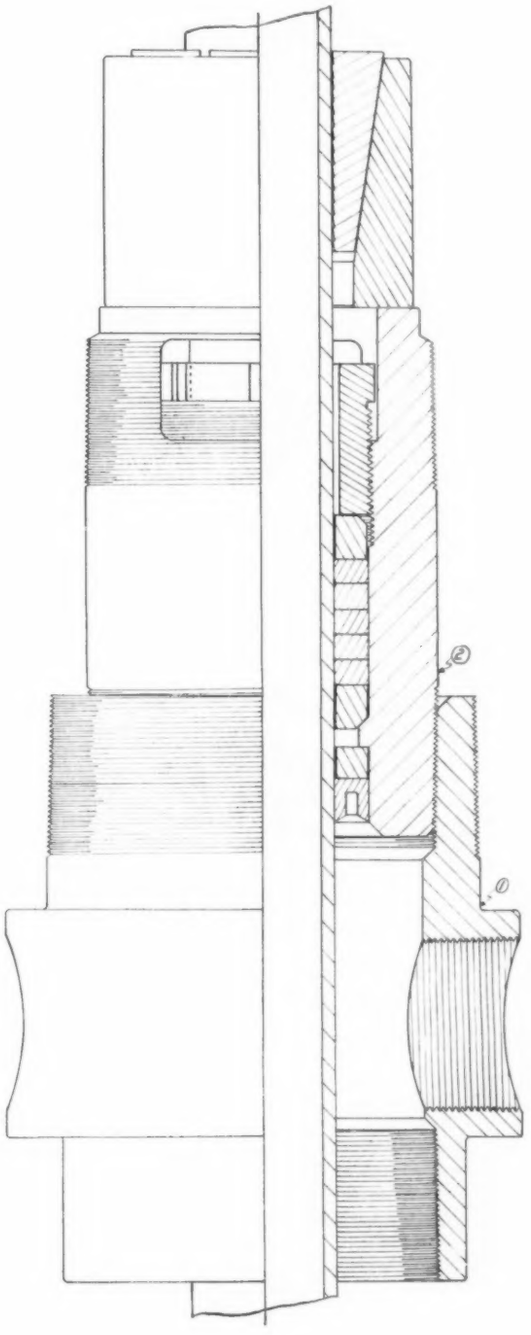
The use of packers in wells with a high bottom-hole pressure brings about a problem in the design of the packers themselves as well as in the design of the tubinghead. If the packer is, for instance, being run to correct a defective string of casing, it is possible that the pressure above the packer may decline to such an extent that the full weight of the tubing will no longer be sufficient to hold the packer expanded against bottom-hole pressure. Such a situation arose in a gas well last summer. A packer was landed under pressure in the bottom joint of casing, and the casing immediately loaded with water. The leak in the casing must, however, have been reasonably close to bottom, and rather large, since it was necessary to pump water into the casing every day to keep it loaded. So long as this was done, the packer held satisfactorily for a matter of a few weeks; when the operators, however, finally failed to do this, the packer gave way.

The bottom-hole pressure in this case was about 1250 pounds. With the packer expanded against the walls of the 7-in. casing, the bottom-hole pressure was acting on the packer upward with an effective collective pressure of approximately 41,000 pounds. The weight of the tubing, resting on the packer acting to hold it expanded against the bottom-hole pressure, was only 15,000 lb., or 26,000 lb. less than the force with which bottom-hole pressure was acting against the packer from beneath. When the pressure above the packer was lowered to less than 800 lb. by failure to keep the casing loaded, the packer undoubtedly moved up the casing level several feet, tearing itself up and corkscrewing the tubing.

Running a hook-wall packer upside down, so that the slips will prevent upward travel of the packer, will, in some cases, satisfactorily meet such a situation. Such a packer run upside down may, however, present difficulties if it is to be pulled some time in the future. A form of packer has recently been designed to overcome these difficulties. This packer employs a pressure-seal packing element and a slip construction similar to that employed in removable bottom-hole chokes, with provision made for locking the slips in the retracted position when pulling.

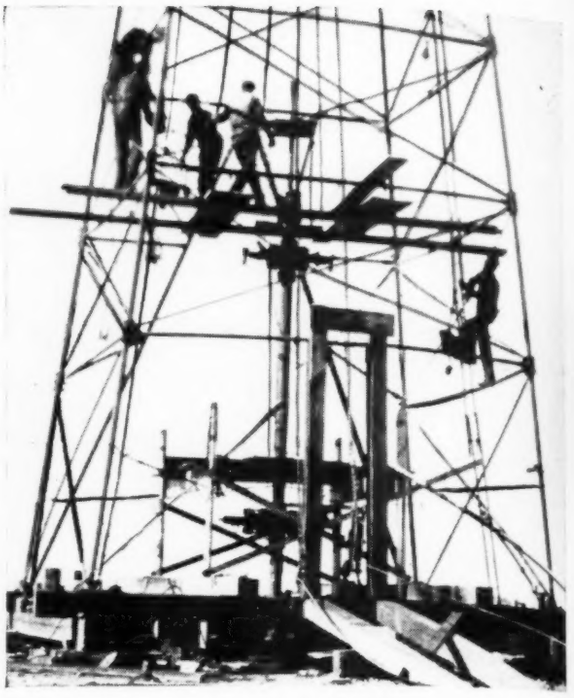
In contrast to the above condition where the lowering of pressures above the packer caused the packer to move up the hole, it often is the case that the pressure beneath the packer is lowered so that the packer actually moves down the hole a few inches. At the moment a packer is landed under pressure, the pressures across it are equal and only the weight of the tubing is acting to expand the packing element. Subsequent lowering of the pressure beneath the packer by feeding the well through the tubing will set up a pressure differential across the packer tending still further to compress its packing element. This probably accounts for the several inches of "settling" that usually follows when such a well is produced through the tubing. This situation should be taken into consideration at the time the packer is landed, particularly if a part of the weight of the tubing string is carried on slips at the tubing head. Six inches of "settling," or further compression of the packing element, will considerably reduce the effective weight of the tubing on the packer.

If the packer is to be run against a high bottom-hole pressure, it is essential, for two reasons, that the tubing be plugged immediately above the packer during the running operations. Before being collapsed, most packers will, under high pressures, permit enough leakage into the tubing around rivets, etc., to create a hazard during the running. More important still, however, if the tubing is plugged beneath rather than above the packer, a load equal to the cross-sectional area of



Permanent type of tubinghead suitable for running packers under pressure

Lubricating a packer under pressure into a well at Jal, New Mexico



the tubing times the well pressure per sq. in. is thrown on the rivets that hold the packer in the open, or running, position. In the case of 2½-in. tubing, a well pressure of 1500 lb. would result in a load of nearly 10,000 lb. being placed on the packer rivets, a pressure that might be enough to cause them to sheer prematurely and thus to set the packer sooner than anticipated. When more than only a few feet of anchor is to be run, it is necessary to plug the tubing twice, once at the bottom of the anchor and again at a point just above the packer. When the upper of the above seals is made, the lower seal must be broken in order to equalize pressures across the packer rivets. This is very simply accomplished either by the combination of the patented tubing plug customarily employed by the Southern States Company, Inc., placed at the bottom of the anchor and a removable blank bottom-hole choke just above the packer, or by the combination of two of these tubing plugs, the valve of the upper, however, having a small enough outside diameter to permit it to fall through the body of the lower after pressures across the upper valve have been equalized. As the packer is lubricated into the well casing, sufficient leakage takes place through the packer to allow the upper of the two valves to seat quickly and to equalize pressures across the lower, allowing it to drop from the closed position.

When running packers into the deep wells at Big Lake it was considered advisable to flow the wells through the tubing for a few minutes just before actually setting. When the packers had been run to within only a few feet from the point at which they were to be set, the tubing seal just above the packer would be removed and the well allowed to flow into the separators for a few minutes. The top joint of tubing would then be plugged with a blank removable bottom-hole choke and the packer lowered the few remaining feet and set. After the tubing had been packed off at the surface, the control heads removed and the tubing again tied into the separator, this blank choke would be pulled and the well allowed to feed at regulated rates either through the tubing from the formations beneath the packer or through the casing from the formations above the packer.

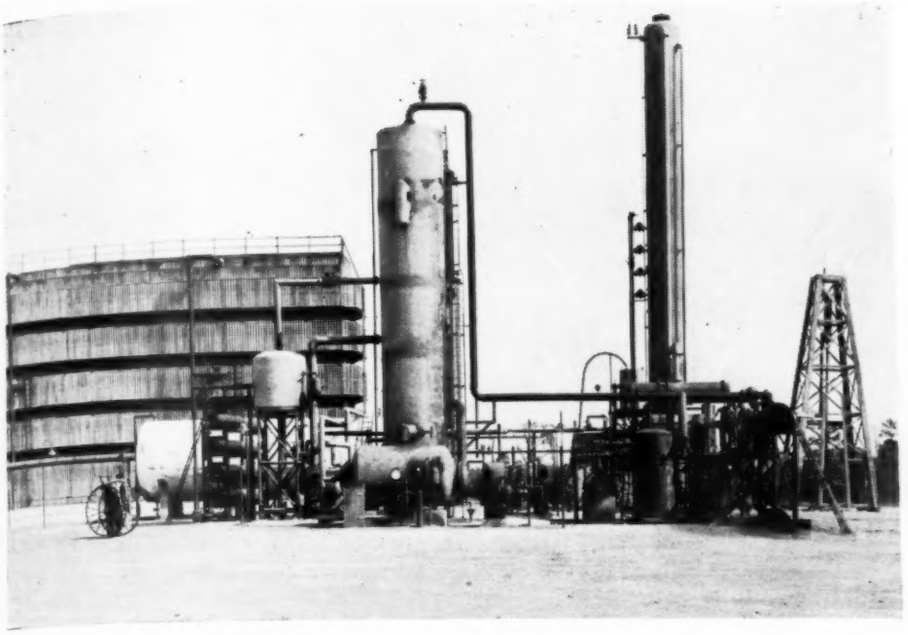
Various operating conditions occasioned the running of the many packers during the past year. In several instances these packers were used to correct defective casing or casing seats. In other instances, such as at Hobbs, Jal, and Yates, they were run to separate a gas horizon from an oil-producing horizon, in order to lower the gas-oil ratios. At Big Lake they have been run to separate two distinct oil-producing horizons. In other instances they have been run to plug off bottom-hole water. An interesting test is now being made near Amarillo, where a packer is being set in an attempt to separate sweet-gas horizons from sour-gas horizons. Near Refugio, the use of a packer was resorted to about a year ago as the only means of controlling a gas well that was cratering as the result of a bad casing break near bottom. Although the well was equipped with tubing at the time the casing break occurred, mud could not be pumped down the tubing as rapidly as it would flow out through the break. The tubing was plugged and pulled under pressure and re-run with a packer. When the packer reached the defective point in the casing, the flow pulled it into the break. The packer was then snubbed down with all the power that was available. Pump pressure was applied on top of it to drive it still farther into the break. After this had been done, it required only a few minutes pumping through the tubing to kill the well.

One of the operators in the Yates field completed an unusual packer operation under pressure early this summer. This company decided to drill a 12¼-in. hole under pressure into the producing horizon, then to come back up the hole and set 10-in. casing without loading the well. Since running 10-in. casing under pressure would have been a decidedly hazardous operation, a 12¼-in. blank removable bottom-hole choke was run in on a 4-in. drill stem and set in a hard lime a short distance above the pay. Releasing the pressure on top of the choke caused the pressure-seal sleeve to be expanded against the wall of the hole and completely to plug the well. They then cut loose from the choke, pulled the drill stem, and ran and cemented the 10-in. casing without trouble. After the cement had set, the plug was drilled under pressure and the choke driven to the bottom of the well and left there.

While even the best of packers will not under all conditions effect a complete and permanent seal, recent improvement in their construction and in methods of running and pulling under pressure have so broadened their possible application that it is expected that their use, while more or less frowned upon in the past, will in the future occupy a more prominent part in oilfield operations.

Drilling Operations Active in Germany

Drilling operations in the oil fields of Hannover, Germany, continue active and several new wells are reported to have been brought in, states a communication from Consul G. R. Willson, Bremen. The Gewerkschaft Wintershall A. G. reported the finding of oil in the Nienhagen field at a depth of 900 meters. This well is said to produce approximately 700 bbl. per day. It is stated that the well was brought in in 46 days, the shortest time ever required to drill a well in Germany. The Gewerkschaft Krug von Nidda reported the striking of oil in the northern section of the Nienhagen field at a depth of 700 meters. The Erdolbergbau A. G. Celle reported that it struck petroleum in the Oberg field at a depth of 320 meters. It is stated that the gas pressure at this well is very strong and that the production of oil is expected to be good.



Distillation and stabilizing units of the Hanlon Gasoline Corporation's plant in Gregg County, East Texas field

East Texas Casinghead Gasoline Plant

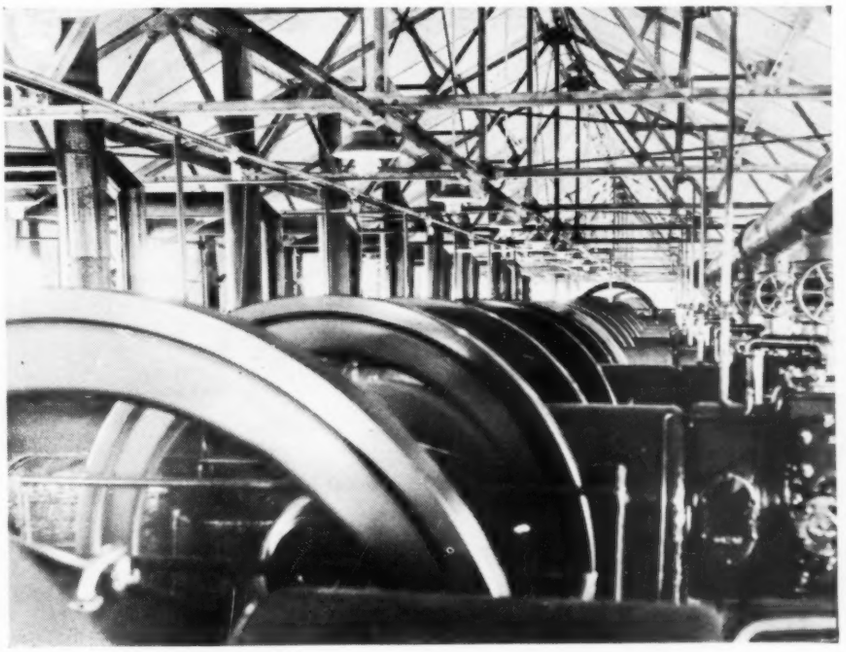
By FRANK H. LOVE

Efficient Gas Gathering System Worked Out to Give Uniform Flow to Plant Intake

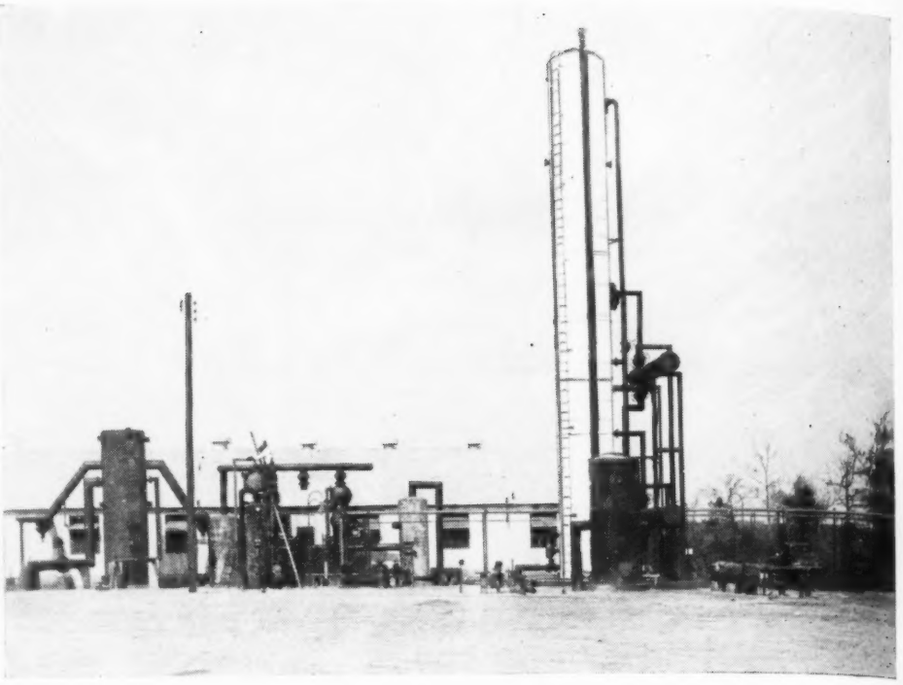
THE gathering of casinghead gas for the manufacture of natural gasoline in East Texas presents certain problems not encountered in older and more stabilized fields. The reasons for this are several. Proration in East Texas permits of each well producing but 20 to 35 bbl. of crude daily, determined by the bottom-hole pressure. For a gasoline plant to operate on a continuous schedule, as it must to be profitable, it is necessary that gas be taken from a large number of wells, and since the allowables on the wells differ widely, and the time required to run the production shows considerable variation even in the case of wells permitted the same number of bbl. daily, obtaining a steady flow of gas to the plant each hour of the day necessitates detailed engineering procedure.

Wells in older fields that can be pumped continuously produce crude somewhat uniformly, and the supply of casinghead gas, therefore, also is uniform. To gasoline plant operators in such fields obtaining a uniform gas flow is no problem, in marked contrast with East Texas conditions. Some wells in the latter field are able to produce their allowable in less than an hour's time. Others making the same production require considerably longer. Because of the many factors involved in obtaining a uniform gas flow the system employed by the Hanlon Gasoline Corporation at its plant in Gregg County, in operation less than a year, is of interest. So accurately has its schedule been worked out by the engineering personnel that the volume of incoming gas does not vary more than ten per cent for any one hour of the day.

The Hanlon plant is processing 13,000,000 cu. ft. of gas daily. To supply this volume connections are made with from 1325 to 1350 wells on 165 leases. Gathering lines totaling 100 miles in length, including both vacuum and residue, are being operated. The system is composed of eight main lines



The compressor room houses eight 115-hp. and six 160-hp. units; one 50-hp. air compressor, and one 80-hp. recompressor



The absorber is equipped with two oil coolers, which can be seen at the right of the column. Their use reduces by half the quantity of mineral seal oil required

varying in size from 8 in. to 20 in. at the plant intake, scaling down to as low as 4 in. as the distance from the plant becomes greater and the volume of gas flowing through that portion of the line less.

The flow system adopted for the Hanlon plan is based upon a complete knowledge of each well from which gas is taken. The allowable of each, and the time required to produce that allowable, must be known definitely. From this basic information a schedule is worked out with the producing organizations whereby the wells are flowed or pumped in a rotation that will assure a continuous and uniform flow of gas. Since it is necessary that the flow be uniform through each of the eight main gathering lines as well as for the system as a whole, the detailed analysis involved is readily discernible.

Adhering strictly to its program of gas flow the Hanlon plant has obtained an excellent record of gasoline recovery. By producing the wells in a uniform manner the gas enters the gathering lines at a low pressure, and tests made at the plant reveal that as the pressure increases gasoline recovery decreases approximately as follows:

Pressure Lb.	Gasoline Recovery Gal. per M.
0.0	4
2.5	3
5.0	2.5
10.0	2.25
15.0	1.7
20.00	1.5

Recoveries in all instances do not correspond exactly with these figures, the weather and other factors entering in, but in general they are representative for the area.

High recovery of gasoline is important not only to the plant owner, but the producing companies from whom the wet gas is purchased as well, since the rate of payment is a sliding scale based on gasoline content.

A typical casinghead gas contract used in East Texas contains the following clause with respect to price:

The buyer shall pay the seller for the casinghead gas delivered hereunder a price per M. cu. ft. computed on the following basis:

1. When gasoline content is less than .75 gallons per M. cu. feet:

(a) When average price is two cents per gallon, or less, five per cent of the value of the gasoline.

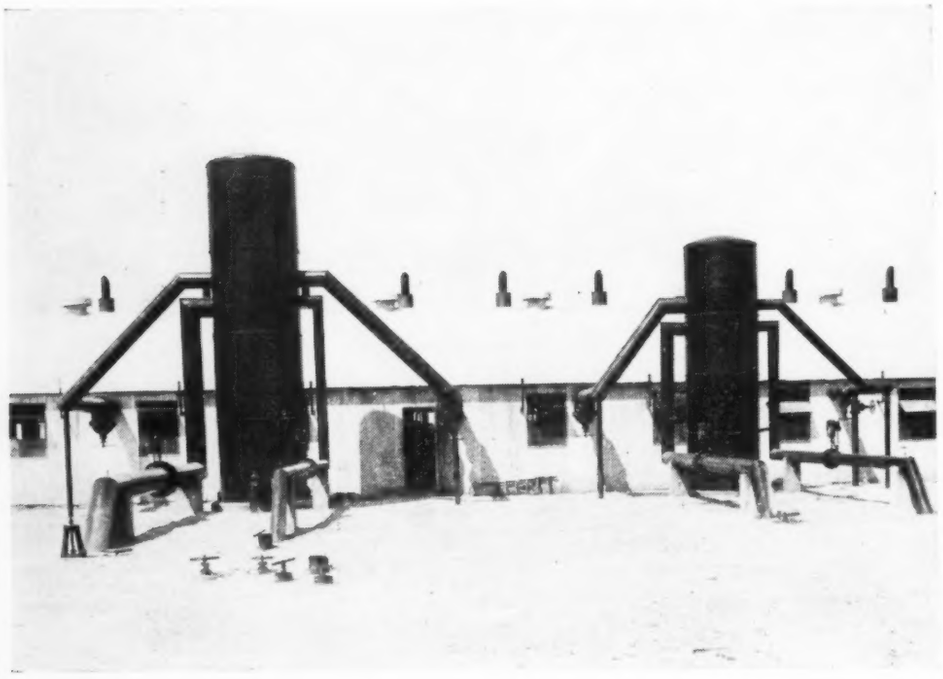
(b) When average price is more than two cents, but less than four cents per gallon, ten per cent of the value of the gasoline.

(c) When the average price is four cents, but less than six cents per gallon, 15 per cent of the value of the gasoline.

(d) When the average price is six cents per gallon, or more, 20 per cent of the value of the gasoline.

2. When gasoline content is .75 gallons per M. cu. ft., but less than 1.75 gallons per M. cu. feet:

(a) When average price is two cents per gallon, or less, ten per cent of the value of the gasoline.



Intake scrubbers are equipped with a mercoid switch mounted on a liquid level controller for shutting down the plant automatically should too large a quantity of oil enter with gas

These features make

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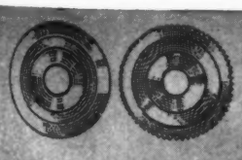

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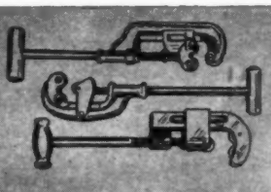

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Trimo, Barnes and Saunders type.

TRIMO PIPE VISE
Replaceable parts, patented construction to prevent wear.

(b) When average price is more than two cents, but less than four cents per gallon, 15 per cent of the value of the gasoline.

(c) When average price is four cents, but less than six cents per gallon, 20 per cent of the value of the gasoline.

(d) When average price is six cents per gallon, or more, 25 per cent of the value of the gasoline.

3. When gasoline content is 1.75 gallons per M. cu. ft., or above:

(a) When average price is two cents per gallon, or less, 15 per cent of the value of the gasoline.

(b) When average price is more than two cents, but less than four cents per gallon, 20 per cent of the value of the gasoline.

(c) When average price is four cents, but less than six cents per gallon, 25 per cent of the value of the gasoline.

(d) When average price is six cents per gallon, or more, 33 1/3 per cent of the value of the gasoline.

From this it is noted that the rate of payment to the seller varies from five to 20 per cent of the value of the finished product for gas with a content of less than .75 gal. per M., up to 15 to 33 1/3 per cent of the total value on that having a recovery of 1.75 gal. per M. or above.

The Hanlon gasoline plant embraces a number of interesting features in addition to its gathering system, chief of which is its complete automatic control. It is a low-pressure absorption-type plant, operating on approximately five inches of vacuum and 45 lb. discharge pressure. At present two grades of gasoline are being manufactured: 18 lb., and 28 lb. Reid. The gas is of such composition that no treating is required. The following is an analysis of a composite sample taken over a period of 24 hours during the winter months.

Compound	Mol per Cent*	Gal. per M.
Methane	44.13	
Ethane	9.50	
Propane	27.37	
Iso-butane	6.15	2.01
N-butane	8.38	2.64
Hexanes and heavier	1.12	.46
Pentanes	3.35	1.22
	100.00	6.33

*Numerically equivalent to gas volume per cent when the sample is vaporized at pressure-temperature conditions such that its components do not appreciably deviate from ideal gas laws.

FOOTNOTE—The gas here analyzed produced 2.47 gal. per M. of 26-70 gasoline.

Incoming gas to the plant first passes through four intake scrubbers for removal of impurities and then is discharged to the compressors by means of an overhead header that ties into the suction of each compressor. The gas is fed into the header at various points in order to give an even distribution to all compressors. Each scrubber is equipped with a mercoid switch, placed at a port approximately 18 in. below the vapor line leading to the compressor cylinders. The switch is mounted on a liquid level controller, and each of the four switches is connected to the magnetos of all compressor units, so that in event of oil entering the scrubbers with the gas in too large quantities a short circuit is set up and the units shut down within 15 seconds.

The total compressor hp. is 1880, the compressor room housing eight 115-hp. and six 160-hp. units, in addition to one 50-hp. air compressor for supplying starting air and blowing the water well, and one 80-hp. recompressor. These compressors are equipped with air filters, relief valves, and the usual safety appliances. Auxiliary equipment consists of two 165-hp. gas engines, one driving a lineshaft, the other being used as a standby. To the lineshaft is belted a generator, three centrifugal water pumps, and three triplex oil pumps. The water pumps have a total capacity of 4500 gal. per min., and the oil pumps a capacity of 450,000 gal. per day.

The absorber, six ft. in diameter and 52 ft. in height, is so designed and equipped that it is necessary to circulate but 50 per cent as much mineral seal oil as required in the older type units. To accomplish this, two oil coolers have been placed on the outside of the absorber column. When the mineral seal oil has traversed approximately half the length of the column it flows by gravity through the first cooler and back into the absorber column, the same procedure occurring when the oil reaches the second cooler farther down. Cooling of the oil in this manner reduces evaporation and the volume required, therefore, is appreciably lessened. The absorber unit is operated at 41 to 42 lb. pressure.

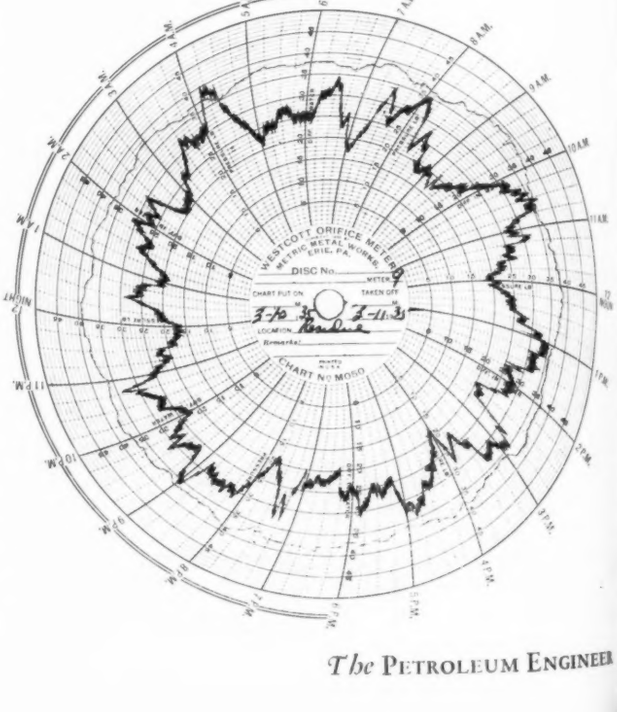
The distillation equipment consists of four heat exchangers, one preheater, a flash tank, one still, a reboiler, two reflux pumps, a priming condenser, a reflux accumulator, a secondary condenser, and one raw surge tank. The still is operated at 50 lb. pressure.

The stabilizer, 64 ft. in height, 54 in. in diameter, and operated at a working pressure of 250 lb., is capable of handling 120,000 gal. of raw stock daily. Equipment for this unit consists of a reboiler, preheater, reflux condenser, accumulator, a reflux pump, a charge pump, and a standby pump that can act for either of the other pumps.

Six 75-hp. oilfield boilers generate steam for the plant. Each is equipped with a boiler fuel governor and feed-water regulators. Residue gas is the fuel used and the units are operated at 150 lb. pressure.

The cooling tower is of the atmosphere type and has a capacity of 2500 gallons. In the base of the tower are open-type oil coolers, and in addition to cooling water, the tower is thus employed for reducing hot mineral seal oil to the desired temperature.

Six tanks provide a storage capacity for finished gasoline totaling 130,000 gallons. The gasoline is pumped from storage by a steam pump, 8 x 8 x 12, to a loading rack three miles from the plant where a double track provides facilities for handling 15 cars simultaneously. The vapor recovery system with which the rack is equipped has reduced loading losses to a low level, approximately one-half of one per cent to two per cent, depending upon the grade of gasoline being shipped.



To an operator whose experience has been entirely in older and more stabilized fields this residue gas chart may appear to be extremely "ragged," but for East Texas it is considered near perfect

Proper Carburetion Facilitates Use of Natural Gas in Internal Combustion Engines » »

BECAUSE of its abundance in some fields, due consideration is not always given to the most efficient use of natural gas in internal combustion engines. In many fields, however, the supply of gas is not so plentiful; and in a number of these fields the gas supply is nearing the point of exhaustion. Pressure regulation and the use of a properly designed carburetor will aid in cutting down loss of power and will improve economy. In fields where the gas supply is known to be limited or short-lived, a combination carburetor will provide a means for immediate change from natural gas to gasoline for fuel.

Pressure on the supply line may vary to a considerable extent, depending on location and conditions, and necessitate the installation of a suitable pressure regulator. When gas of approximately 1100 B.t.u. is used with one type of carburetor, the pressure should be adjusted so as not to exceed 12 in. of water; but with gas as low as 550 B.t.u. the pressure should be greater.

Natural gas as a fuel for multiple-cylinder, internal combustion engines is different in characteristics from a wet fuel such as gasoline. There are none of the problems of crankcase dilution, manifold heat, or distribution. Its octane rating is generally equal to, or better than, the best grades of gasoline with Ethyl fluid added. It has become a rather general trade practice to estimate the consumption of gas used by a multiple-cylinder engine at ten cu. ft. per b.hp. hour. The results of certain tests in cu. ft. of 1100-B.t.u. gas consumed at various loads are as follows:

Per cent of max. hp.—	80	75	70	65	60	55	50	45	40	35	30
Cu. ft. hp.-hr.—	10.4	10.6	10.8	11.2	11.5	12.0	12.5	13.2	14.0	15.0	16.0

It is essential for the proper operation of engines using natural gas for fuel that the supply line be of sufficient capacity. Since the power unit may be installed some distance from the "service," a guide for recommended sizes of various straight-run lines when the line capacity is computed at eight in. of water is given in the following table.

Multiple-cylinder power units using natural gas for fuel are often required to give continuous service. For such duty a reserve in speed and power should be provided for. Owing to hours of service, it should not be expected that spark plugs will last as long as they do with automobiles. When engines are shut down for a period, moisture, the result of condensation, may "short-out" the plugs when the engine is started up again. With many engines the thermal efficiency may be low on account of the cooling water being too cold. There is a direct relation between cooling water temperature, efficiency, and motor life. Greater volumetric efficiency may be obtained with cold intake manifolds. Higher comparative power output and lower fuel consumption may be obtained with increased compression ratio.

New types of fuel regulator, natural gas carburetor and combination carburetor for both natural gas and gasoline have recently been designed by the Ensign Carburetor Company of Los Angeles to meet various field conditions. These are made with cast-iron or cast-bronze to meet the kinds of service to which they may be applied. The operation of the fuel regulator shown in Fig. 1 has the same general function as the float bowl of a gasoline carburetor. It is an improved differential type, and by the use of two diaphragms permits compact construction. Without accurate control of gas pressure, proper metering of gas at the carburetor cannot be accomplished. The carburetor also shown in Fig. 1 was designed with an aim to assure ease in starting and without any floating or moving parts. It is two-stage with one position of choke control for starting and the other for running.

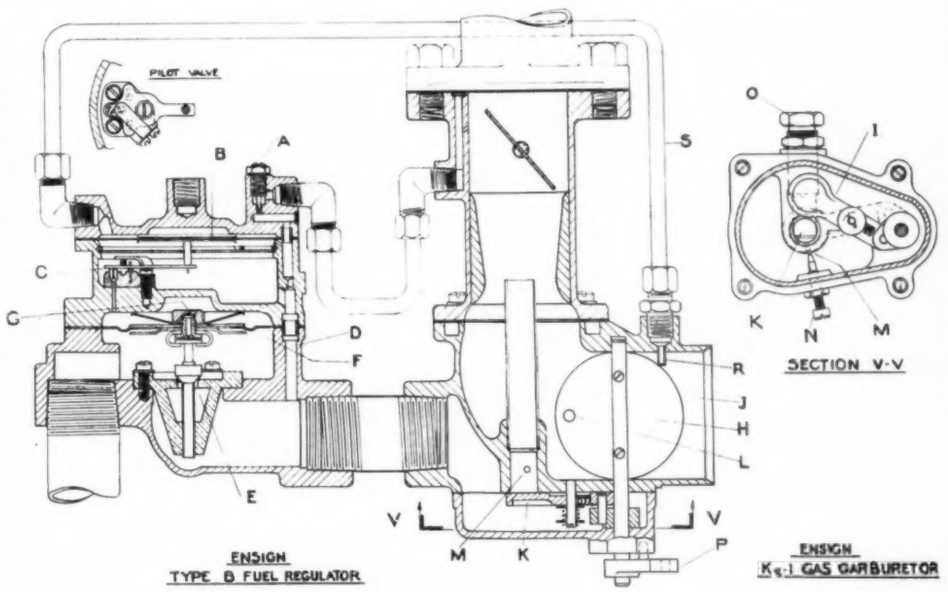
The combination carburetor is, of course, desirable where switching from natural gas to gasoline is either advantageous or necessary. The float control valve on the gasoline float bowl shuts off the gasoline, protects the needle valve by holding it firmly against its seat and also holds the float mechanism firm against the effect of vibration while the bowl is empty.

Hp. Load	Probable Max. Cu. ft. Gas Required	MAXIMUM LENGTH IN FEET				
		¾ in.	1 in.	1¼ in.	1½ in.	2 in.
10	125	240	1000			
15	200	90	400	1200		
20	250	60	250	750		
25	300	40	150	500	1300	
35	425	.....	100	270	700	2800
50	600	.....	50	130	350	1500

Fig. I.

The Fuel Regulator—"A" is the idle fuel adjustment, "B" the pressure or pilot diaphragm, which, when the engine is at rest, has atmospheric pressure on both sides. "F" is the main diaphragm with the pressure of gas supply on both sides, directly connected underneath through the main passage and above restricted passage "G." Slight suction from the engine communicated through passage "D" to the under side of diaphragm "B" pulls it down, thereby opening pilot valve "C." The opening of pilot valve "C" relieves the pressure of gas over "F," permitting it to lift. When "F" lifts it opens main fuel supply valve "E." When engine is at rest valve "E" is held closed by its own weight and by the pressure of gas. It should be understood that the extent of suction from the engine through "D" controls the position of "B," which in turn governs the pressure over "F" by bleeding through "C," thereby regulating the position of "F," which in turn regulates "E" through which the carburetor obtains its gas supply. Pressure of gas at fuel regulator outlet is held at approximately $\frac{7}{16}$ in. of water below atmosphere. Oil in the gas will not impair action of Fuel Regulator valves.

The Gas Carburetor—Position of disc "H" and shutter "I" as shown by drawing is the running position. For starting, lever "P" moves "H" and "I," which closes air intake "J" and fuel passage "K." Air for starting is drawn through opening "L" and gas through orifice "M," which is adjustable by "N." Main fuel passage "K" is adjusted by "O," which is power adjustment. When once properly set, idle fuel adjustment "A," gas starting adjustment "N," and main fuel adjustment "O" should be locked tight and will remain fixed. The air passage through "R" and "S" to the upper side of "B" compensates for any air cleaner resistance, which would otherwise cause a rich mixture.



ENSIGN TYPE B FUEL REGULATOR

ENSIGN K-1 GAS CARBURETOR

KEROTEST

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The **STRONGEST**
Valves for the
DEEPEST *Wells*

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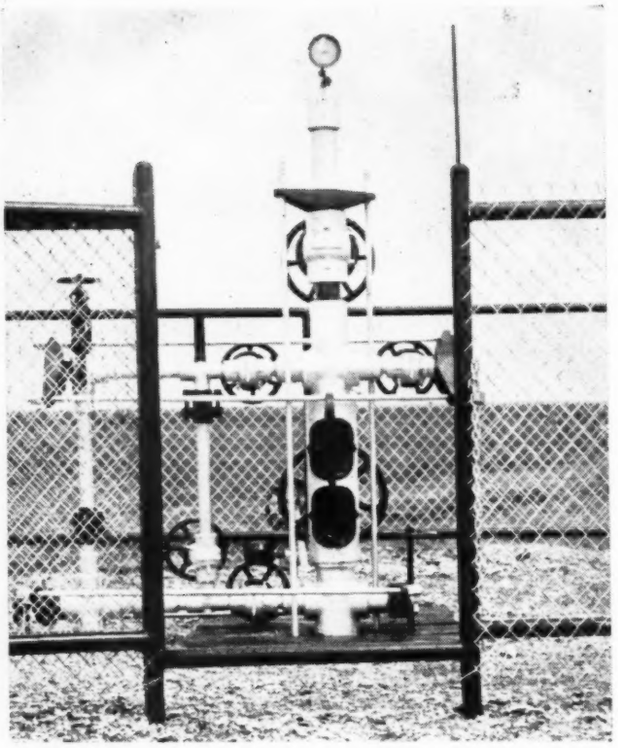
STEEL

Handling High-Pressure Wells In The Gulf Coast

By K. C. SCLATER

WHEN high pressures are encountered in the fields of the Gulf Coast, more than ordinary care has to be exercised during drilling in order to keep control of wells. Maintaining control of a well is frequently a very ticklish problem, for the cavey nature of the formations present peculiar difficulties that tax the ingenuity of the operator. Two conditions, either one of which may lead to almost insuperable difficulties are: (1) the presence of relatively shallow sands carrying high-pressure gas in large volume and (2), the presence of so-called heaving shale. Either of these two conditions may give rise to the most treacherous kind of drilling. Each has been responsible for many of the blow-outs that have characterized development operations in the Gulf Coast fields.

Rapid strides have been made in developing methods and means to control wells, and such mishaps as wells getting out of control are becoming less frequent. Evidence of this is that despite the fact that there has been a steady increase in drilling depth, blow-outs are of less frequent occurrence, especially considering the number of drilling operations.



This Gulf Coast well had a pressure in excess of 2500 lb. when brought in and produced wet gas in large volume and little oil. The Christmas tree fittings, consisting of Hughes retractor head, valves, and nipples are all 6000-lb. pressure test

Where wells are drilled in high-pressure areas it is general practice to provide suitable equipment that will aid in maintaining control under the most extreme conditions.

In one area where high-pressure gas sands relatively close to the surface were encountered drilling had to be suspended on account of cratering. A large part of the trouble originated in a serious blow-out in the first well drilled. The formations near the surface are porous and unconsolidated. The gas from below accompanied by water entered these surface formations and caused them to become highly charged with gas. This resulted in cratering over a large area. Subsequently, these surface formations became treacherous to drill. Blow-outs were frequent and extreme measures had to be resorted to in order to penetrate them without getting into trouble.

One such measure was the use of pressure-drilling equipment and flush-joint drill pipe. After setting and cementing the conductor string the wells were drilled under pressure, the pressure being applied not by increasing the pressure at the mud pump discharge but by restricting the circulation returns with an adjustable choke. Instead of 7-in. liners on the mud circulating return two 3-in. lines were used, one of which was equipped with an adjustable choke. When a blow-out threatened, one 3-in. line would be closed at once and the choke on the other line used to build up a high pressure as quickly as possible.

A 13⅜-in. cross with 7-in. side openings was used on the casing. The two 7-in. lines were equipped with 3000-lb. plug valves placed near the cross and another on the 3-in. line near the end where it discharged into the ditch. These return lines were swedged from 7-in. to 3-in. just beyond the first plug valve.

Up until the 13⅜-in. surface string was set, Colox was used as a weighting material in the drilling fluid, bringing the weight to 13 lb. per gallon. When the 13⅜-in. surface casing was set it was equipped with a 13⅜-in. x 10¾-in. Rector casinghead above which was mounted a 13⅜-in. Hughes 3000-lb. cross with two 7-in. side openings for the mud return lines. Above the cross a 13⅜-in. 3000-lb. test drilling valve was placed and above this a Hydril pressure-drilling head with upper and lower packer assembly for drilling under pressure.

Ordinarily only two strings of casing are required in Gulf Coast wells, the surface string and the flow string, but in blow-out areas it is common practice to set three strings of casing. In areas of this kind the mechanical factors involved in keeping pressure on the well are probably more important than the chemical treatment of the mud. When, however, heaving shale is present in the hole the mud fluid becomes important, and one or more blow-out preventers are used on the well.

These may be of the core type or bowl type, or both. Speed in operation is an essential element in blow-out preventers. They may be operated by pressure or manually and by remote control if necessary. One of the bowl type shown in the accompanying illustration is of recent design and is mechanically operated by remote control. It is placed under the derrick floor and may be attached to any blow-out equipment of the Hosmer type. The type shown is operated by

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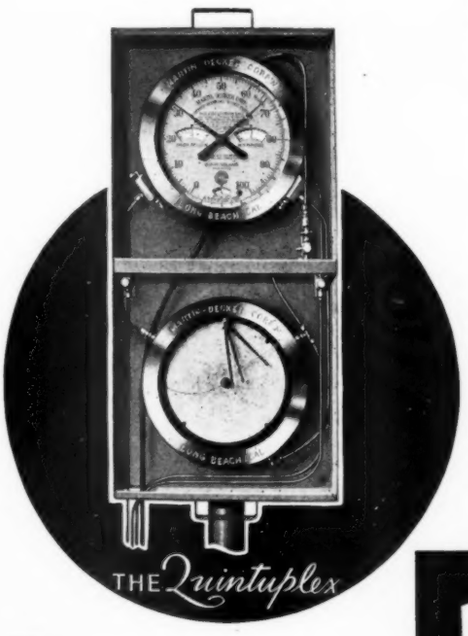

THE "MARTIN-DECKER" — "QUINTUPLEX" — DRILLING CONTROL INSTRUMENT combines all of the above indicators in one 12-inch gauge case which is mounted in the upper half of a steel box and installed directly in front of the driller as he stands at the brake. In the lower half of the box a three-pen recorder is mounted. This inscribes a 24-hour record of weight, mud pressure and torque strain on the drill pipe on one 12-inch chart.

Under most conditions, operators prefer to install the complete "Quintuplex" but you may buy it in any combination or each instrument may be purchased separately.

These instruments are described more fully in our booklet, "Drilling Control." If you care for a copy we will be glad to send it wherever you direct.

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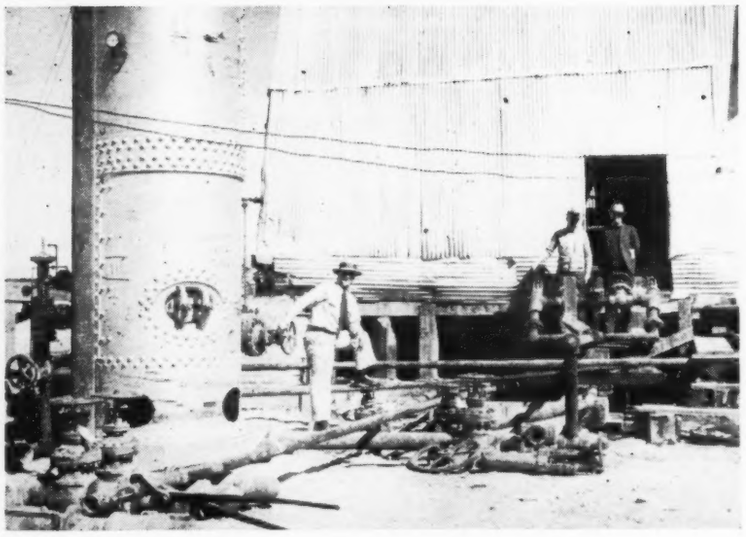
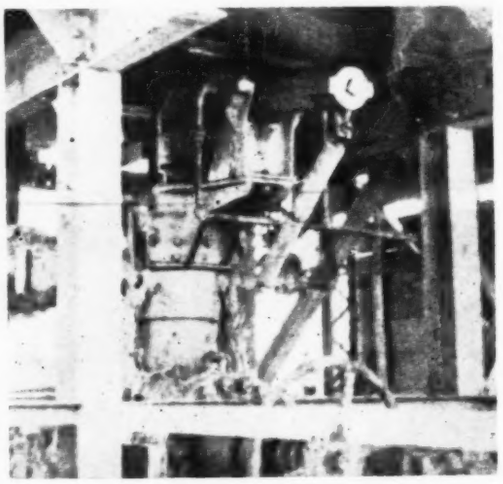


Separator with control valve manifold, including adjustable chokes, hooked-up to the drilling-fluid circulation system of a high-pressure well being drilled-in under full control by the pressure-drilling method

hydraulic pressure. By pulling a lever placed at some position convenient to the driller the packing assembly is clamped around the drill pipe under the derrick floor. In the normal position the packing assembly is out of the way of the casing opening during drilling and does not interfere with running drill pipe. A pressure gun shoots the packing assembly around the drill pipe when the lever is pulled. The drill pipe is then lowered and the packing assembly thus locked in the bowl. This gives a secure rubber seal capable of holding against a well pressure of 5000 lb. or greater. In case there should be insufficient drill pipe in the well to hold the packing assembly down, automatic locking dogs are provided to hold the packing assembly securely in the head and produce an effective seal. Lifting the pipe until the tool joint comes in contact with the lower section of the assembly will expand the rubber sufficiently to give an initial seal. This operation usually requires 5000-8000 lb. upward pull on the drill pipe. To remove the packing assembly, special wrenches are provided for retracting the locking dogs so that the packing assembly may be lifted out of the head by the raising of the drill stem. By reversing the lever on the lines to the double-acting piston the driller can remove the assembly from around the pipe, placing it in the middle position ready to operate at a moment's notice when the preventer is again required. The control levers for operating the pressure gun may be placed in an easily accessible position so that the driller can operate it with his foot. The lines to the pressure gun are connected to the water line, pressure on which should be regulated to 150 pounds. A relief valve is inserted in the line through which the pressure is used to force the pressure gun forward and place the packing assembly around the pipe. In an emergency, high-pressure steam hose may be used instead of pipe.

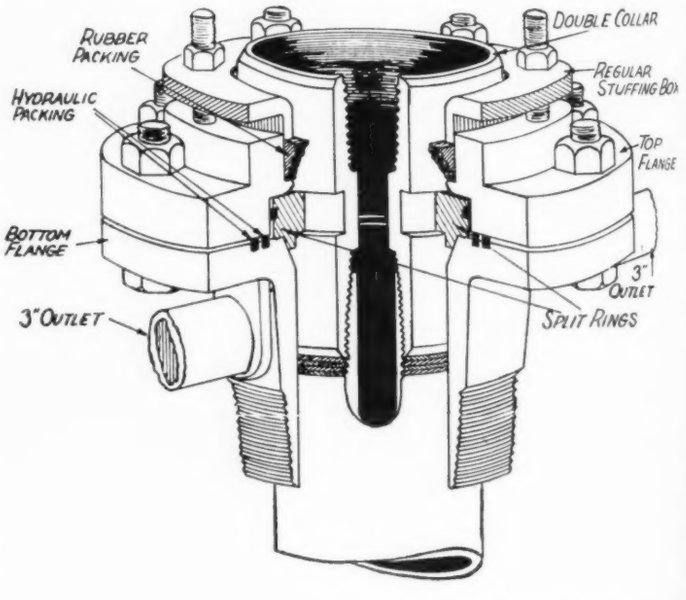


A McEvoy (Hosmer type) blow-out preventer inserter connected to master drilling valve on a high-pressure well

One of the most important requirements of a blow-out preventer is dependable, quick action so that a seal can be made in the shortest possible time when a blow-out threatens. It is the practice on high-pressure wells to have blow-out preventer drills by the drilling crews. In this way the blow-out prevention equipment is kept in thorough working order and the drilling crew becomes familiar with its operation. The value of drills lies in the fact that no time is likely to be lost in closing the preventer before the conditions become critical. Usually these blow-out prevention drills are logged by the driller.

Controlling high-pressure wells successfully when drilling through heaving shale usually requires all the skill and ingenuity that can be exercised. Drilling through heaving shales in high-pressure areas is one of the most disconcerting problems faced by operators in the Gulf Coast. Chemical treatment of the drilling mud and care in the handling of the mechanical equipment in the well are necessary. Experience indicates that even the dip of the heaving shale is important. A steep dip is conducive to heaving and the treatment of the mud may require to be changed as the dip changes.

The importance of weight when drilling through heaving shale has also come to be recognized within the recent months. The pressure of the mud is a function of the time it takes to build up a mud sheath on the wall of the hole. High pressure builds



This casing control head is designed for use on high-pressure wells

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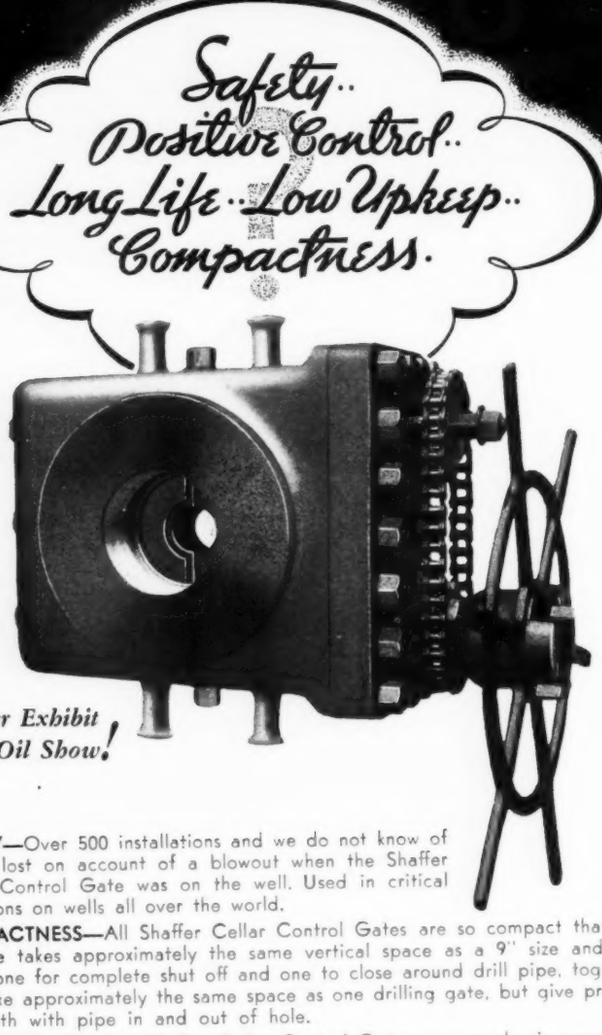

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- **LOW UPKEEP AND EASE OF MAINTENANCE**—The ram rubbers are the only parts that ordinarily need replacing. This is easily and quickly done, as only one flange needs to be removed to pull out the whole ram assembly. Rams to fit any size casing, tubing or drill pipe that will pass through the gate are as quickly changed. A Shaffer Gate installation is rarely left on the well when it is completed. Thus its cost per well is extremely low.

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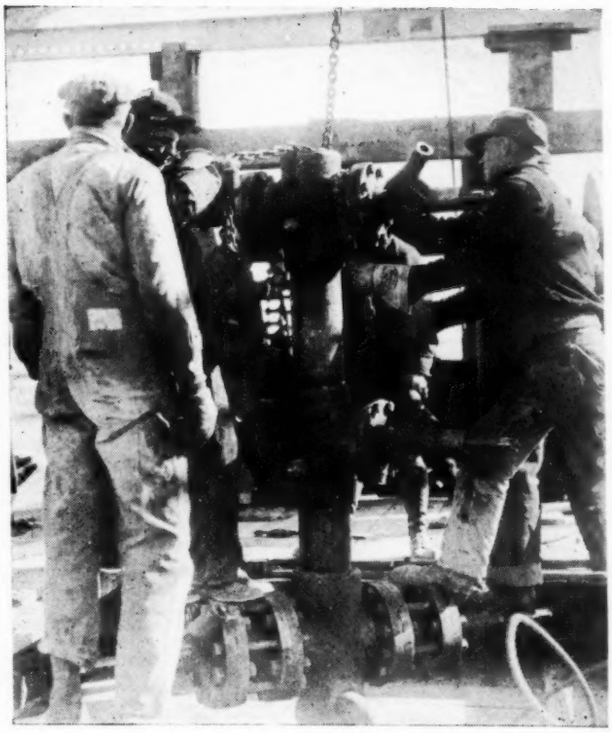
up a sheath of mud on the wall much quicker than does low pressure. It takes about two days on the average for heaving shale to show the deleterious effect of coming in contact with water. On the third day trouble will start. If the hole is drilled too quickly, say ten ft. per hr., not enough time is allowed for building up the sheath of mud. The weight of the mud will speed up the walling process but in itself is not enough. Instead of drilling at a speed, such as ten ft. an hour, it may be the better part of wisdom to drill about two ft. an hour or 50 ft. per day.

In drilling with salt-laden drilling mud certain precautions must be observed if Aquagel is to be added. It is necessary to mix the Aquagel first in fresh water at such a concentration as to result in a thick paste, then after complete hydration to allow the Aquagel paste to mix with the salt-laden mud. It has been observed that when Aquagel is mixed with salt-laden drilling mud that an appreciable percentage of the colloidal material is destroyed by the action of the salt. If dry Aquagel is added directly to the salt-laden mud, seven times the normal quantity of Aquagel must be used to produce the equivalent viscosity. In other words approximately only 1/7 of the original colloidal matter remains unaffected by salt and 85 per cent has been destroyed by this sequence of mixing. By following the procedure of mixing the Aquagel to a paste with fresh water first, only about 15 per cent is destroyed by the action of the salt. With intelligent control of the drilling mud, the rate of drilling, and suitable equipment, great thicknesses of heaving shale can be drilled without trouble. Recent practice in the field has demonstrated this. As much as 1100 ft. of heaving shale was drilled through successfully lately by the Yount-Lee Oil Company in a well at Big Hill. In this well a Barrett-Robishaw wire line drilling and coring bit was used to drill through the heaving shale. By using this type of bit pulling of the drill pipe to renew the drilling bit was unnecessary. Treatment of the mud and the rate of drilling were vigilantly controlled. At one time a blow-out threatened and 20,000 lb. of weight material was quickly added. From 1100 ft. down three mud pumps were used, one for pumping the mud through a mixer and the other two for circulating while drilling. It took four months and seven days to drill to 6341 ft. and land and cement the casing.

It was already observed that the



Blow-out preventers used on a deep well for running in tubing under high pressure

heaving shale usually causes trouble if it has a steep dip. Usually when the shale layers are flat little trouble is experienced in drilling through them. In the vicinity of salt domes the strata are usually tilted at high angles. By employing directional drilling methods it is possible to avoid drilling through highly-tilted beds. Indeed it is possible to deflect the direction of the hole so that the well penetrates the shale where it lies at only a slight angle; it is often possible to avoid penetrating heaving shale entirely by drilling into the salt dome itself and then deflecting the hole directly into the oil producing horizon. These are comparatively recent developments of handling high-pressure wells in heaving shale areas.

In the Greta field, Refugio county, a high-pressure gas sand overlies the oil sand, which is about 4500 ft. deep. Pressures of 1500 to 1600 lb. were encountered in this area. In this field the practice is followed of setting a liner and formation packer to shut off the gas. Unless this is done the gas-oil ratio increases and eventually shuts off the oil flow. In one such well a 6-in. back-pressure valve, about 15 ft. of 5-in. O.D., .010-gauge screen, 15 ft. of formation packer, 50 ft. of blank liner and a ratchet packer seven ft. long were placed in the hole. Setting points for the packer were determined by running a Schlumberger instrument.

The Sam Fordyce field in South Texas is a high-pressure area. The producing sand lies at a comparatively shallow depth, about 2800 ft., but the calculated bottom-hole pressure is 1400-2000 pounds. There is a high-pressure gas sand about 1000 ft. above the oil sand. High gas-oil ratios have been reduced in this field by deepening the wells and setting blank liner to cut off the gas. Only a few ft. of sand at the bottom of the liner is allowed to produce through the screen. The wells are tubed close to bottom and a high fluid level is carried in the casing in order to maintain a low differential pressure at the face of the sand. Gas is bled off at the casing head to allow the oil to rise in the casing. Railroad Commission regulations in this field require that the gas-oil ratio not exceed 1250 ft. per bbl.; that all wells be produced through a separator; and that all fittings be tested to 300 lb. and be good for 3000-lb. working pressure.

Much of the development in the Gulf Coast in the future will entail deep drilling. Already 12 fields are producing from depths below 7000 ft., and four of them are more than 8000 ft. deep. Skill in the handling of high-pressure wells must, therefore, become increasingly important in the successful completion of wells in the fields of the Gulf Coast.

R. L. Armitage Transferred to Dallas

R. L. Armitage has been placed in charge of the North and East Texas territory for the Smith Separator Company of Tulsa, Oklahoma. Armitage, who will make his home in Dallas, was transferred from headquarters at Tulsa, and enjoys a wide acquaintance throughout the entire Mid-Continent area.

U. S. Rubber Announces New Appointments

W. M. Ballew, manager mechanical goods sales, United States Rubber Products, Inc., Kansas City, Missouri, announces the appointment of William O. Kupper, to cover the Oklahoma oil fields as sales engineer, assisting Wesley Batten, of Tulsa, Oklahoma, supervisor of oil field sales.

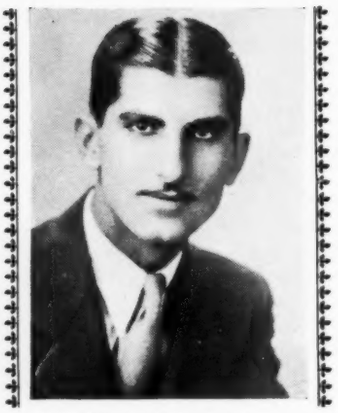
Announcement also is made of the appointment of I. M. Caldwell as technical sales engineer to cover the Kansas oil fields. He will have his headquarters in Wichita, Kansas. Caldwell received his mechanical engineering degree from Oklahoma A. & M. College and enters sales engineering after practical experience in the refinery and production departments of the Tide Water Oil Company.

"Oilwell" No. 46 General Catalog Being Distributed

A welcome piece of advertising literature prepared for the oil industry is the new "OILWELL" No. 46 General Catalog that is just off the press and in the process of distribution.

This book is most comprehensive. Of particular interest are the sections devoted to drilling and pumping equipment, which feature the latest developments in this type of machinery.

Handsomely bound in a black cover with the familiar "OILWELL" orange panels, the new catalog is a departure from the old size book. Although the book contains but 686 pages, the page size has been increased, almost a third more items are included than appear in the old No. 45 Catalog, and it makes a more convenient book to handle.



M. T. HALBOUTY

Conservation of Colloidal Material in Native Drilling Muds

By M. T. HALBOUTY
Geologist and Petroleum Engineer,
Yount-Lee Oil Company, Beaumont, Texas

TOTAL costs of present day drilling muds, especially in the Gulf Coast, are such that every precaution and technique are employed by the petroleum engineer in taking advantage of every desirable quality already present in a native mud to minimize these costs and still maintain an excellent mud. One of the most important characteristics that a mud must maintain is that of colloidal strength. A mud with a high percentage of colloids can be handled chemically as well as physically with greater ease and less cost than a mud that has a low percentage of colloids. Every precaution must therefore be used in maintaining a high percentage of colloids, and to keep them in their proper form and physical characteristics best adapted to the drilling conditions involved.

The characteristics of native colloids formed by the bit and pumps as hole is made through plastic and gummy shales are such as to assist drilling in that hole a great deal. These colloids are produced by the action of free water, which acts as the dispersion medium in reacting with the colloidal material; mainly, potassium, calcium, and sodium hydrous aluminum silicates to form the native colloids. It stands to reason that if a mud is made primarily from the colloids derived from a shale body, the mud thus formed would be best adapted for further penetration of that particular body. There then would be a mud with a chemical characteristic similar to that of the shale body, and no detrimental reaction would take place between the mud and shale to cause any swelling of the latter —if the other mud prerequisites are taken care of, such as, free water. Consequently, when plastic and gummy shales are being drilled the engineer should make use of mud that is being made by the bit and pumps by the addition of a certain amount of water to it to act as the dispersion medium for the colloidal material that is being cut up by the bit. Further use of the shale cuttings could be made if they in turn were churned to a plastic state and water added to absorb the colloidal material present in the cuttings.

It is a common practice with the author to determine the cubic feet of hole being drilled per hour, then, by catching from the shaker, note the amount of cuttings coming out of the hole per hour. From the difference of the two, it is concluded that the rest of the cuttings are being made into mud, allowing an approximate error of one to two per cent for cuttings adhering to sides of walls, etc. Therefore, a certain amount of water per hour is added to the mud to act as the dispersion medium for the material that has a tendency to go into suspension in the circulating fluid as colloidal material.

These colloids are naturally active, and the pH value would be relatively high. This pH value could easily be maintained and peptized higher if necessary by the addition of chemicals from time to time. Every precaution must be made in the tests to assure that no excessive amount of free water is added over the colloidal material held in suspension; these tests should be conducted at least every two hours. On several wells it has been the practice to make such tests every hour. The success of such water-native-colloidal material treatment is not only significant but also economical. There are several cases where with such treatment complete definite layers of heaving shale have been penetrated without the addition of anything else except peptizing chemicals. By definite layer is meant a single stratum of shale having the identical chemical and physical characteristics throughout and in the same geologic zone. Where a change in geologic age is encountered, it is also safe to conclude that the chemical as well as physical characteristics will also change, and such changes practically always require different mud characteristics.

It is not unusual to have to carry three to four different physical and chemical properties in one mud in order to meet the different characteristics in the three to four types of heaving shale—and this is done successfully. In every case, however, the native colloidal material is used as much as possible to form the bases for the necessary requirements of the mud.

It is of course a known fact that chemicals and admixtures play an important part in the treatment of muds; however, their application is the most important. Chemicals should be added only when necessary, for once a chemical is added, other than peptizing agents, the mud has become a real problem and any slight change in chemical reaction could cause serious damage. The engineer should know what, how, and why to add chemicals at just the right time and make tests to observe any slight indication of change from better or worse.

Admixtures are also extremely important. They also should be added in right proportions, mixed in such a manner as to make them part of the mud; to utilize every pound and know that half of what is being added is not at the bottom of the slush pit, and not settling in the hole over the drill collar and bit, a condition that can happen, and does happen, and cause stuck drill pipe. In other words, the engineer must know his mud and above all understand just what is happening in the hole, the formation that is being drilled, its geologic age, characteristics, etc. All factors, native or synthetic, must be recorded.

The native factors are important; too much attention is being paid to synthetic features instead of those that mother nature provides for us. It is believed that little attention is given to native colloids. These can be utilized economically and practically in the treatment of rotary muds. Native colloidal material will aid in maintaining a "treatable" mud characteristic; that is, chemical treatment when necessary can easily be applied. Native colloids once made should not be killed and burnt by the addition of detrimental chemicals. In other words, use every foot of plastic and mud-making shale in the treatment of muds—which in turn will net a savings in the total cost of treated muds.

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Pressure-Operated Blow-Out Preventer of Improved Design

By K. C. SCLATER

DEPENDABLE operation and quick, positive, effective action are vital requirements in any appliance used on a well to prevent blow-outs. A blow-out on a drilling well is much like a fire; unless checked immediately at inception, it may quickly get beyond control and result in serious loss and damage—and possibly disaster.

Drilling conditions in the fields of the Gulf Coast in general are such that the operator is confronted with blow-out hazards more frequently than in the average field elsewhere. This experience has taught him to equip his wells for such emergencies and has been instrumental in improving the design of blow-out preventers.

In Fig. 1 is shown the drilling control valve and blow-out preventer on a well being drilled by the Archer Drilling Company near Fairbanks, Harris County, Texas. These valves, which are manufactured by The Cameron Iron Works, Houston, Texas, embody the most recent improvements in blow-out equipment, among which are several features worthy of mention. In the illustration, the lower valve is a blow-out preventer for shutting off the flow with drill pipe or tubing in the hole and the upper is the type for shutting off the flow through the casing. Both are pressure-operated and can be opened or closed by means of a double-acting piston actuated by air, gas, steam, or hydraulic pressure. They can also be operated manually, and by either method of operation are adapted to remote control.

In the installation shown, which is for 13⅜-in. casing and is the first of several installations now in use, the pressure cylinders are connected to the mud-fluid system. When operated by mud-fluid pressure, opening or closing of the preventer is positive and instantaneous and is not affected by temperature or expansion of the fluid, as when gas, air, or steam is used. A 4-way valve and manifold admit the mud-fluid into either end of the cylinders to open or close the valves as desired.

When the ram or rams are closed a complete seal is effected in an interesting manner. The rubber packing is compressed and completely fills the slot shown in the body of the valve core (see Fig. 2), at the same time the pressure on the outside of the metal retaining ring is also acting and compresses the rubber ring and also the packing in the slot in the body of the valve core, thus forming a complete seal against the well pressure. As can be seen from the design, the packing is easily renewed.

The ratio of the pressure of the rams to that of the piston is three to one. A pressure of 500 lb. on the piston gives a pressure at the ram of 1500 lb., or a pressure sufficient to withstand a well pressure of 3000-5000 lb. per sq. inch.

When a valve approaches the point of complete closure on its seat "wire-drawing" of the fluid usually occurs. If the velocity of flow is high and the mud-fluid carries sand or silt, which it usually does, the wire-drawing action is destructive and will quickly damage the ram rubber and impair or destroy the valve seat. Means to prevent this deleterious action are embodied in the valve construction and consist of two small holes of the proper size in the valve body, one on upstream and one on downstream side of the valve. This simple but effective device, by choking the flow of the fluid through the valve as it is about to close, prevents wire-drawing at the valve seat, for the valve really closes between two chokes incorporated in the valve construction.

Even though the ram rubber becomes worn flush with the edge of the plates to which it is vulcanized, the effectiveness of the seal will not be impaired. This is explained by the fact that the outer edge of plates has a thickness of rubber, which on compression serves to take up any wear and maintain an effective seal (see Fig. 2).

The rubbers suffer no damage from the rotation of the drill pipe in and out of the hole, for they are out of the way and a full opening is provided through the preventer.

Despite these improvements the height and width have been held to about those of standard types of drilling gate valves.

Improvements of this kind that aid in removing blow-out hazards are a contribution to drilling progress.

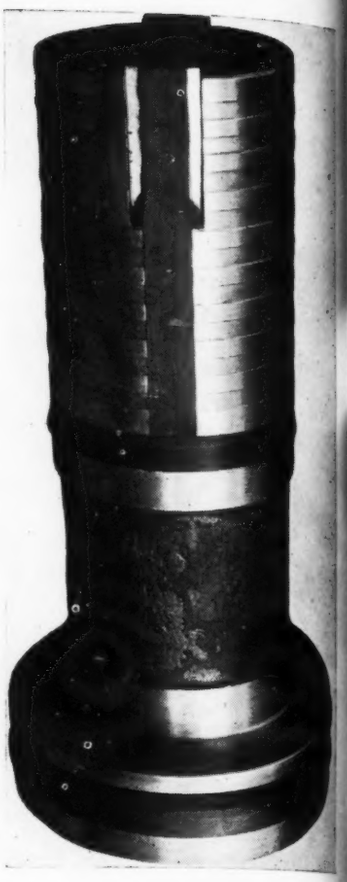

Fig. 2. Ram of the upper valve shown in Fig. 1. Note the thickness of rubber vulcanized to the lower edge of ram plates

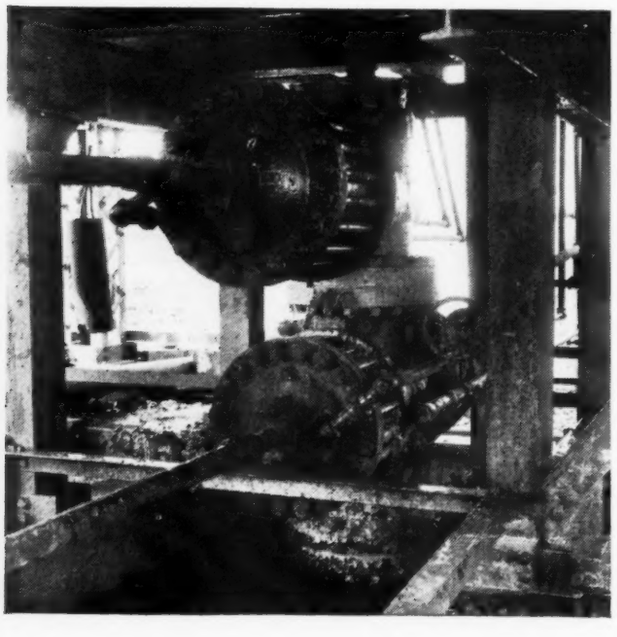

Fig. 1. Blow-out preventers operated by mud-fluid pressure on a drilling well in the Gulf Coast, Texas

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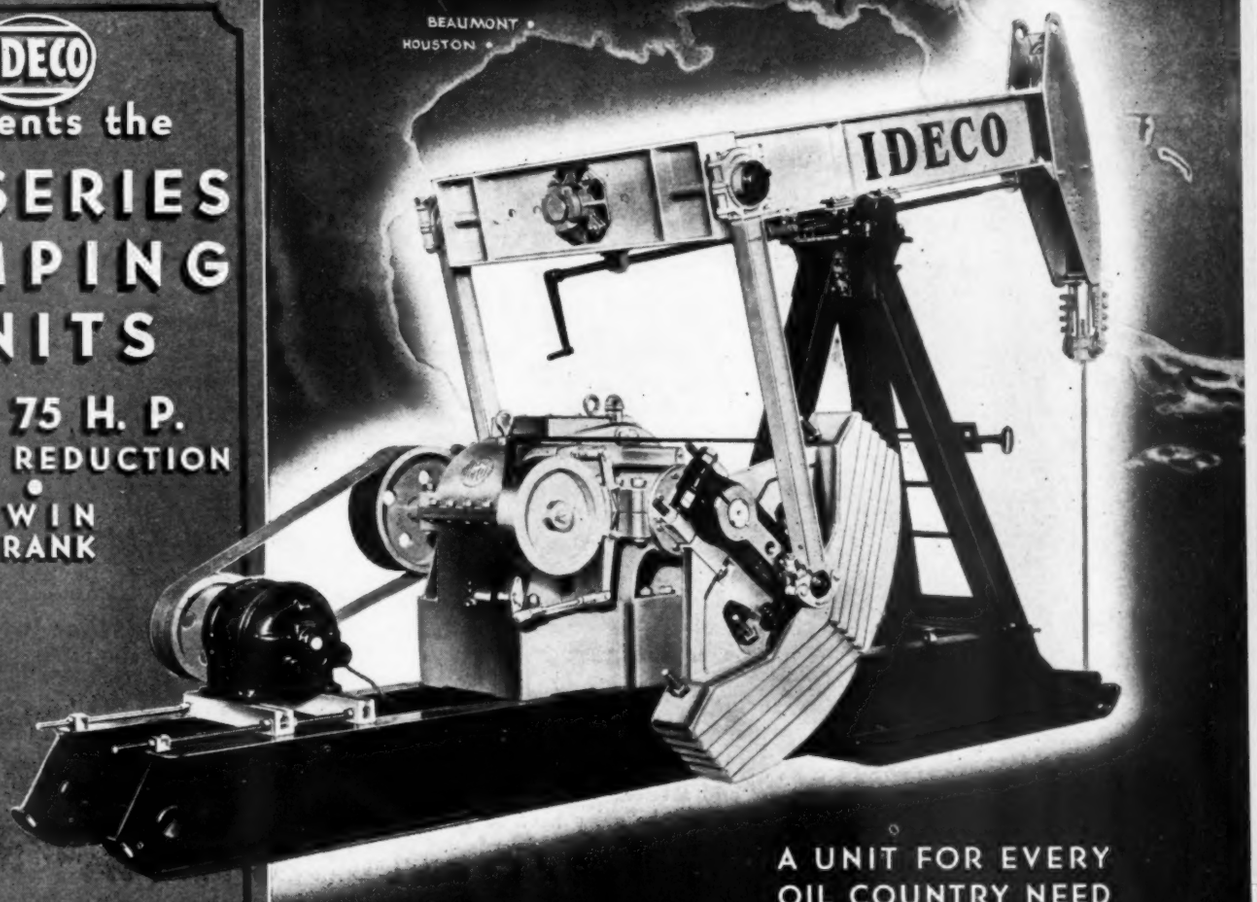

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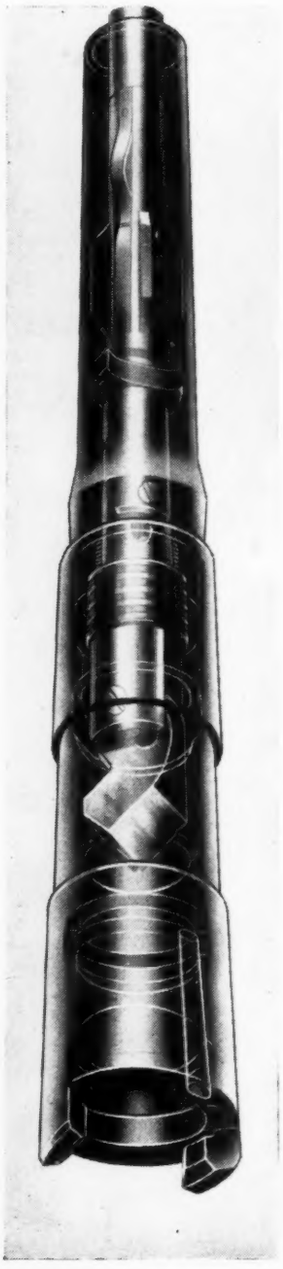
Collapsible-Blade Bit For Drilling Through Heaving Shale[1]

DURING the discussion of the paper entitled "Gulf Coast Drilling Fluid Problems and Their Treatment," presented at the last meeting of the Houston Chapter of the A.P.I., the difficulties in drilling through and setting casing through heaving shale, and in the prevention of blowouts, particularly at the times of drill stem withdrawals, were pointed out. It was, therefore, thought advisable to have presented before this group information on a special type of drilling bit for consideration along with these studies.

A.P.I. paper No. 901-10-D, presented by Mr. George Cannon, research engineer for the Humble Oil & Refining Company, April 21, 1934, is quoted in part as follows: "It has been observed that most blowouts in rotary drilling occur when the drill pipe is being withdrawn from the hole."



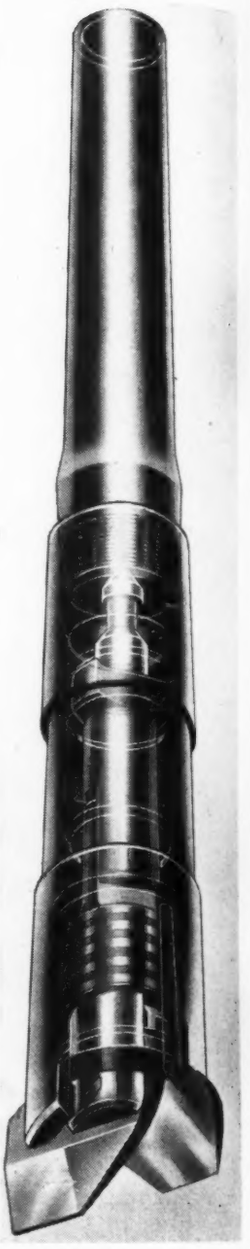
Phantom view of the blade carrier assembly with the drilling blades in collapsed position as they are removed from the bit head

"A review of the drilling operations in two fields now being developed shows that in one of the fields 156 wells have been drilled and eight blowouts have occurred. The trouble in every well occurred while the drill pipe was being withdrawn. Six of these wells were abandoned after reaching a depth greater than 4500 feet. In the other field, 735 wells have been drilled and 19 serious blowouts have occurred. Of this number, 12 occurred as the drill pipe was being withdrawn, one when the drill pipe was out of the hole, and one when the drill pipe was being run into the hole. Of the twelve wells that blew out apparently as a result of a change in mud pressure as the drill pipe was being withdrawn, three wells were abandoned."

Likewise, it has been often observed and frequently stated that heaving shale comes into the drilled hole as the drill pipe is being withdrawn from the hole.

The collapsible-blade drilling and coring bit is so designed and constructed that dull blades and/or dulled core heads can be replaced with sharp drilling blades or sharp core heads without removal of the drill stem. For regular drilling and for exploration drilling, this collapsible-blade drilling bit is made to operate through and on regular internal upset drill pipe.

For sending sharp blades to drilling position at the bottom end of the drill stem, the blades are attached in collapsed position to what is called the blade carrier. This assembly is simply dropped down through the inside of the drill stem where it travels to the bit head on the bottom of the drill stem; upon reaching the bit head, the blades automatically expand to drilling position, and because of the design of the blade carrier are locked in drilling position so that they cannot be collapsed from any external pressure.



The drilling blades expanded and locked in drilling position

After the blades are dulled, they are removed by running a specially designed overshot on a wire line down the inside of the drill stem, which overshot upon reaching the blade carrier engages and attaches itself to a spear head at the upper end of the blade carrier. This engagement causes the spear head to take a center position in the bit head, unlocking the assembly for upward travel. An upward pull from the wire line on the assembly causes the blades to retract in a collapsed position, in which position they travel upward through the drill pipe to the surface. The wire line is operated from an auxiliary reel, similar to that used extensively in the Gulf Coast for wire-line core-drill operations.

For the drilling through and setting of casing through heaving shale, this collapsible-blade drilling bit is designed to operate through and on casing used as a drill stem. In this case the bit head is designed with a large internal bore almost equal to the inside diameter of the casing used as a drill stem. Regular casing

[1] Substance of paper prepared by R. G. HAMAKER and read by G. G. HARRINGTON, Reed Roller Bit Company, before Houston, Texas, Chapter A.P.I., March 19, 1935.

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Illustration shows special steel wire grid back which serves as a foundation binder, giving strong support of bolt heads, and preventing bolts from pulling out. Also the extra thick body which contains no rubber, cotton, wire yarns, or other material affected by heat; and retains its high braking efficiency right down to the grid base.

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with regular couplings has been successfully used for this purpose. Of late, however, external upset casing with regular collars has been successfully used with a feeling of greater safety for the pipe. There are now available new designs of casing threads and couplers, which would no doubt be quite successful for this purpose.

In the drilling of heaving shale with this bit, and with casing for the drill stem, the pipe is never removed from the hole once the drilling bit encounters the heaving shale. After the heaving shale zone has been drilled through and a casing seat reached, the blade carrier assembly is removed and the bit head is set as a casing shoe and cemented in place along with the pipe.

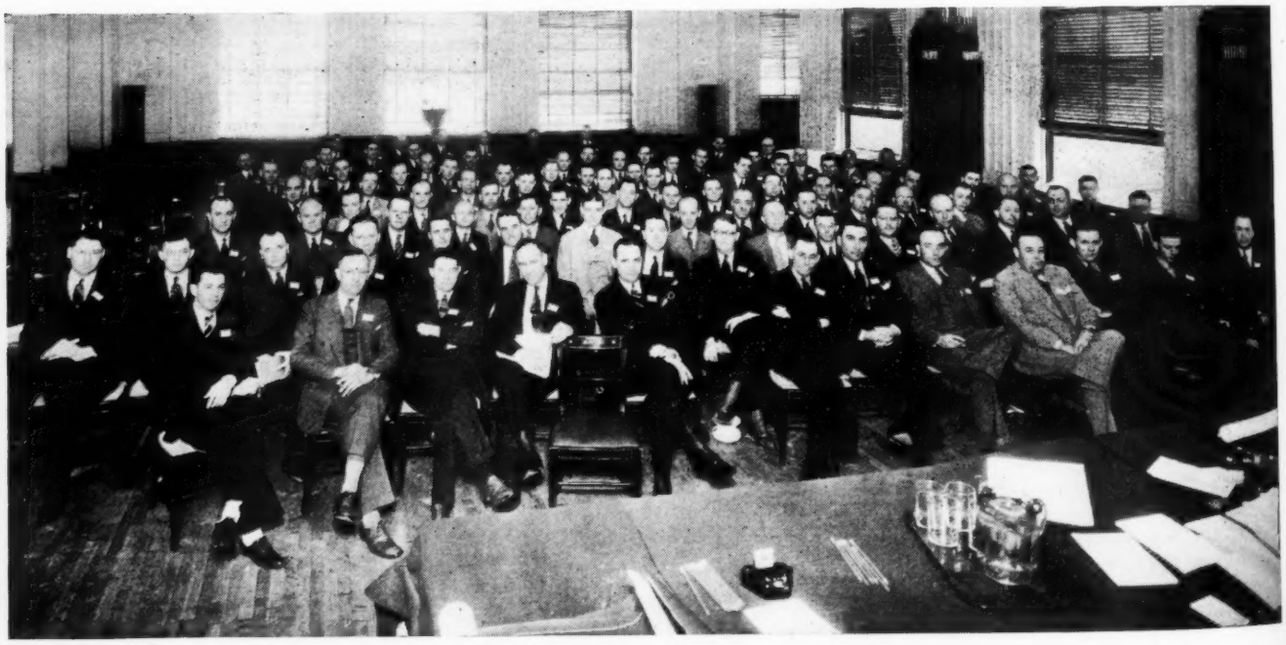
As has been quite generally noted, heaving shale gives trouble when disturbed through change in pressure on the formation. Successfully to drill through and set casing through heaving shale without trouble it is, therefore, highly desirable to start the drilling through the heaving shale zone with this bit rotating at uniform speed, with mud pumps operating at uniform speed, and at uniform pressure. The drilling of heaving shale with this or any other type of drilling tool is always more difficult when following previous unsuccessful attempts during which the heaving shale was pumped and churned into an almost liquid condition by repeated running-in and pulling-out of the drill stem with much changing of hydrostatic pressures. If an unusually bad condition of heaving shale is encountered, necessitating continuous rotation of the drill stem and continuous pumping of the drilling mud, a circulating head can be used to permit rotation of the pipe and circulation of the mud during the blade changing interval.

On a heaving shale job at Goliad, Texas, it was found that between the depths of 4200 ft. and 5000 ft. there was present heaving shale aggregating a total thickness of about 600 feet. That 800 ft. section was originally penetrated with an ordinary drilling bit on the drill stem, but when the drill stem was removed, the shale heaved in and it was impossible to run casing. A collapsible bit was then run in at 4200 ft. on a string of 8⅝-in. external upset casing, which was used as drill stem; the collapsible blade bit used on this job cut a 13¾-in. hole. A mud weight of 10.2 lb. per gal. was maintained, and an addition of from 2000 lb. to 10,000 lb. of new mud was made each day. After one week and four hours of continuous drilling, a casing seat had been reached at 5144 ft., whereupon the blade carrier assembly was removed from the well with the overshot on a wire line. The pipe was then cemented at 5144 feet.

On another well at Damon, Texas, in which heaving shale was encountered, several previous attempts to get pipe set through the heaving shale had failed; the hole was in a very bad condition. A collapsible blade casing bit was run through about 1000 ft. of heaving shale to the salt, where the casing was set. This well was then drilled down to about 8000 feet.

In Panola County, Texas, which is a high-pressure gas area, 23 wells were drilled using the casing as the drill stem until the hole was completed, when the casing was left in the hole and cemented.

Continental Executives and Sales Personnel



Continental Supply Company officials and salesmen, taken during their annual sales meeting held late in March at headquarters in Dallas, Texas. An exceptionally large number attended the gathering

Elements of Applied Petroleum Pipe Line Transportation

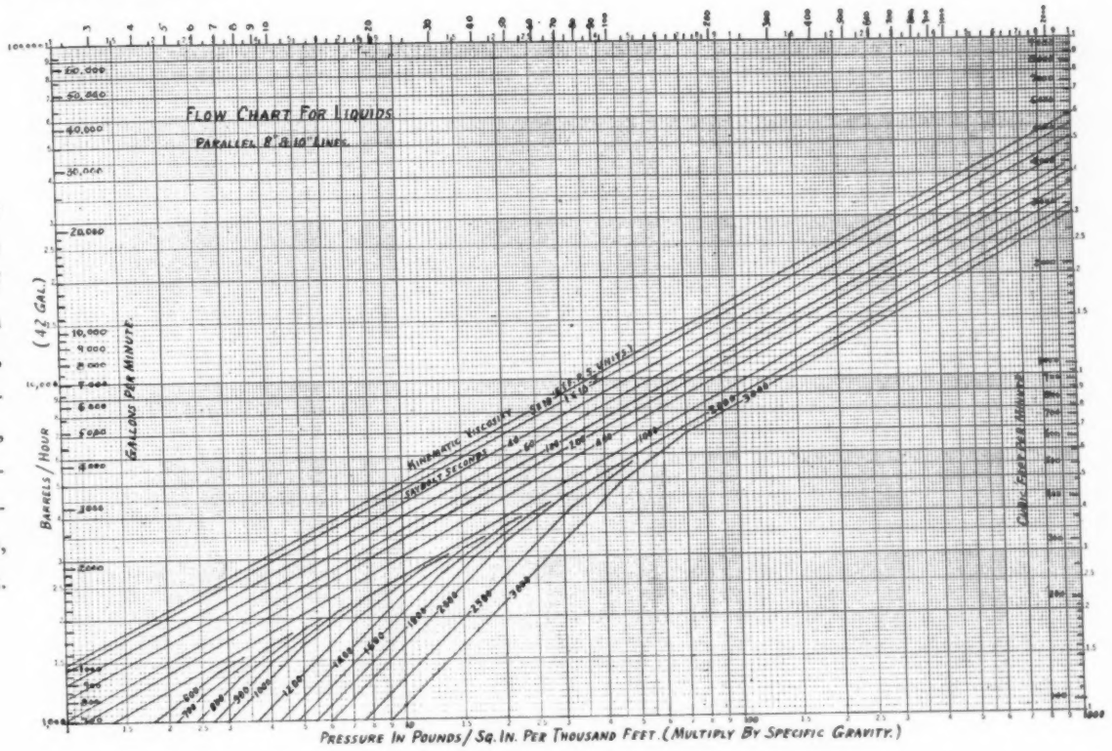
Article 9

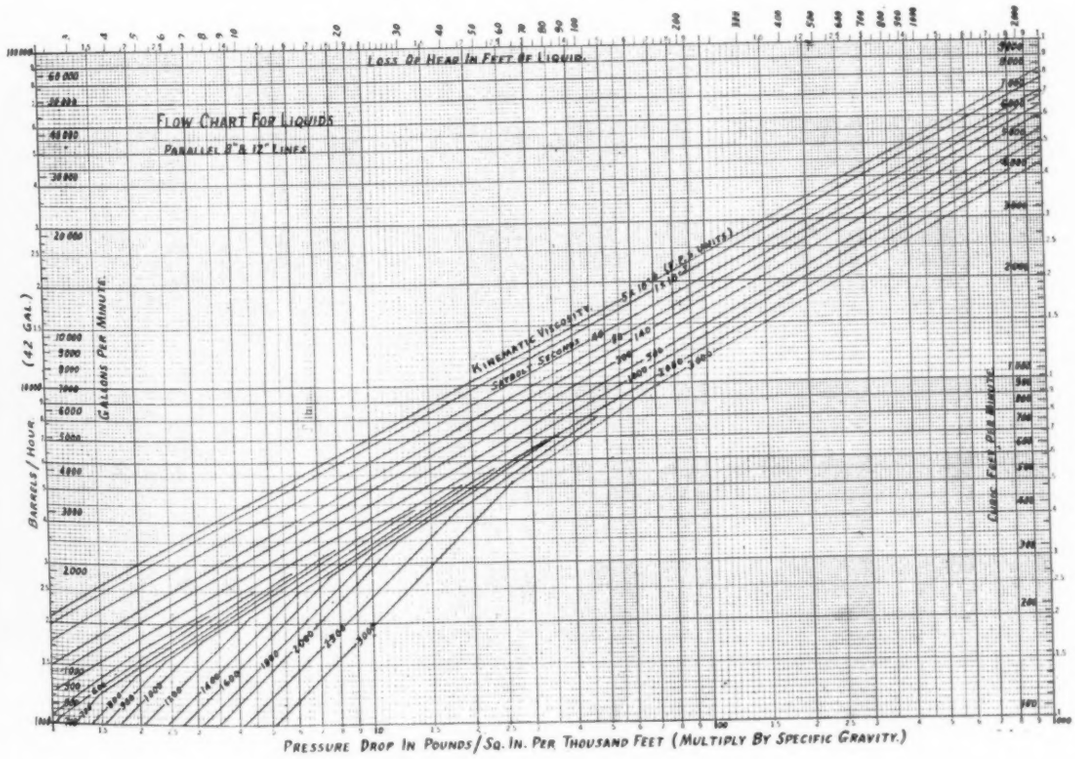
THE FLOW OF OIL IN PIPES AND PIPE LINES

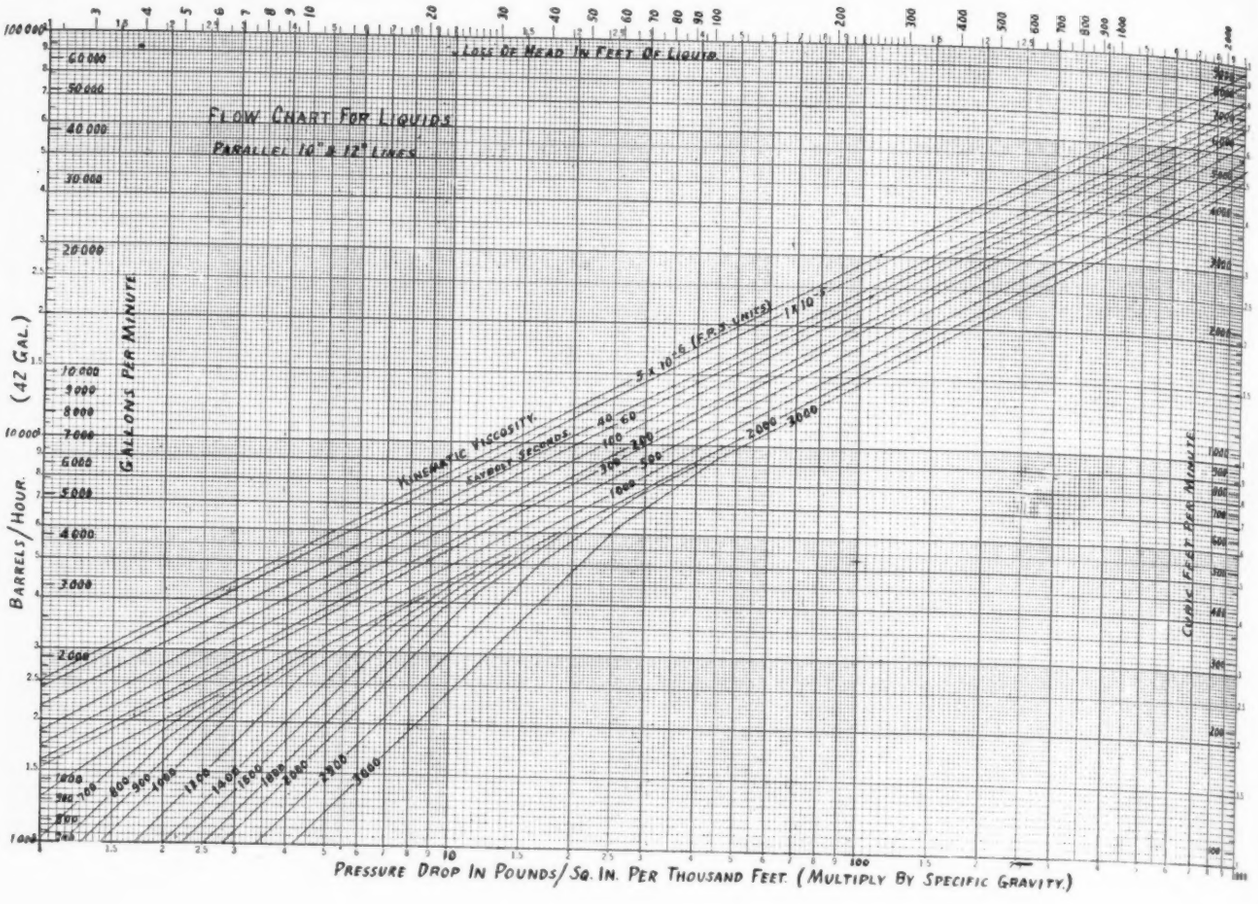
By EMORY KEMLER and L. L. THOMAS

Flow Charts

FOUR charts are given this month for the solution of flow problems in pipes and pipe lines, namely: Parallel 8-in. and 10-in. lines, parallel 8-in. and 12-in. lines, parallel 10-in. and 12-in. lines, and parallel 10-in. and 14-in. lines.


FLOW CHART FOR LIQUIDS
PARALLEL 8" & 10" LINES.
BARRELS / HOUR (42 GAL.)
GALLONS PER MINUTE.
KINEMATIC VISCOSITY
SAYBOLT SECONDS
CUBIC FEET PER MINUTE
PRESSURE IN POUNDS / SQ. IN. PER THOUSAND FEET. (MULTIPLY BY SPECIFIC GRAVITY.)


LOSS OF HEAD IN FEET OF LIQUID.
FLOW CHART FOR LIQUIDS
PARALLEL 8" & 12" LINES.
BARRELS / HOUR (42 GAL.)
GALLONS PER MINUTE.
KINEMATIC VISCOSITY
SAYBOLT SECONDS
CUBIC FEET PER MINUTE
PRESSURE DROP IN POUNDS / SQ. IN. PER THOUSAND FEET (MULTIPLY BY SPECIFIC GRAVITY.)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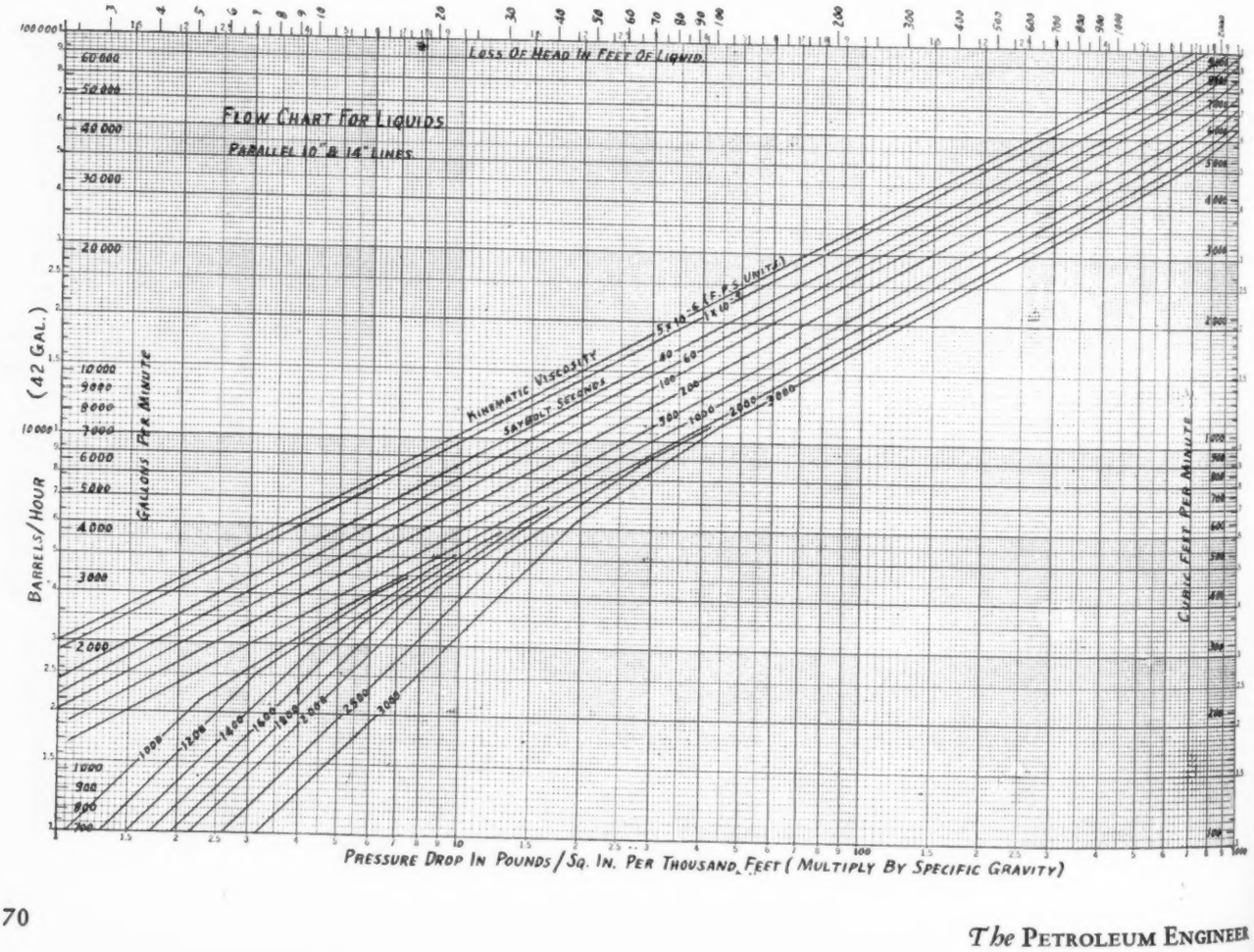
BARRELS/HOUR (42 GAL.)
GALLONS PER MINUTE
CUBIC FEET PER MINUTE
KINEMATIC VISCOSITY
SAYBOLT SECONDS
5 x 10⁻⁵ S.(F.P.S. UNITS)
1 x 10⁻⁵
PRESSURE DROP IN POUNDS/SQ. IN. PER THOUSAND FEET (MULTIPLY BY SPECIFIC GRAVITY)


FLOW CHART FOR LIQUIDS
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5 x 10⁻⁵ S.(F.P.S. UNITS)
1 x 10⁻⁵
PRESSURE DROP IN POUNDS/SQ. IN. PER THOUSAND FEET (MULTIPLY BY SPECIFIC GRAVITY)

Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XVIII

HEATING AND HEAT LOSSES—(Continued)

ALTHOUGH convection is usually classed as a distinct manner of transferring heat, in reality it is a special case of the transfer of heat by conduction. Stagnant films of fluid are found at the boundary walls of vessels and heat must be transferred through these films by conduction. As discussed in Article XVII of this series, these films are effective insulators to the flow of heat and the study of convection resolves itself into ways and means of determining the rate of heat transfer through these films. The first part of this paper will be devoted to a discussion of the most common film heat transfer coefficients.

Overall coefficients of heat transfer, which are coefficients that include the effect of liquid films, the partition wall, and even the dirt that accumulates at the surfaces, are convenient to use but they are not always trustworthy. For this reason, most technologists have resorted to the use of individual film coefficients as outlined in this paper. In order to care for the effect of dirt or scale on the partition wall, they have used so-called fouling factors or resistances. In Article XIX of this series, overall coefficients of heat transfer will be presented.

FILM TRANSFER COEFFICIENTS

Gases. The film transfer rates for gases are usually low. They range from 3 to about 20 for velocities of 5 to 25 ft. per second. At higher velocities the film transfer rate may reach a figure of more than 70. Dixon and McAdams[1] give an equation of the film transfer rates for gases flowing inside of pipes. Monrad[2] gives the same information except for gases flowing outside and across a bank of tubes arranged in a staggered manner. Monrad discusses the transfer rates for the convection section of a pipestill, in detail.

The film rates for gases that circulate only by natural convection were discussed in Article XVII. These transfer rates are very low and seldom exceed three B.t.u. per sq. ft. per hr. per deg. fahr. of temperature difference.

Liquids. The film transfer rates for liquids are usually much higher than for gases. They range from very low values such as 10 or 20 to viscous materials that are moving at a low velocity, to such high values as 1500 for thin materials such as water traveling at a velocity of over ten ft. per second.

The rates for water flowing inside of pipes are given by McAdams and Frost,[3] and the best information on oils is that of Whitman and Morris.[4] The film transfer rates for all fluids are governed by the same fundamental variables, and Sherwood and Petrie[5] have been able to correlate all the data of the above authors on water and oils, as well as data on chemical liquids by a single equation.

Little information is available concerning the transfer rates for liquids on the outside of tubes but in general they seem to be about the same as for liquids flowing inside of tubes.

For the transfer rates of liquids boiling on the outside of tubes only one comprehensive study is available[6] and for liquids circulating by natural convection, the data of Stose and Whittemore[1] is about all that is available. Such information would be most useful in the design of heating coils for storage tanks, etc., and for coil-in-box types of coolers.

Condensing Vapors. Transfer rates for the condensing of vapors are usually high and particularly so if the heat of vaporization of the material is large. Thus with steam, the condensing coefficient may be as high as 4000 in commercial equipment. Small amounts of non-condensible gases, such as air, lower greatly the condensation coefficient.

Transfer rates for condensing steam are given by Othmer[7] and for other materials, the work of Kirkbridge[8] is useful.

Corrosion, Dirt, and Fouling Resistances. The usefulness of the foregoing film transfer coefficients is limited by the accuracy with which we are able to determine the condition of the heating surfaces. If severe corrosion occurs, if dirt or solid materials accumulate at the surface, or if the surface is very rough, the transfer of heat is greatly impeded. The condition of the surface is usually accounted for by means of so-called fouling resistances. In computing the overall heat transfer coefficient, the fouling resistance is used below the line as follows:

$$H = \frac{1}{\frac{1}{h_1} + \frac{L_2}{K_2} + \frac{1}{h_3} + R}$$

in which h_1 and h_3 are the two film coefficients, L_2 is the thickness of the partition wall, K_2 is the conductivity of the partition wall, and R is the resistance due to dirt, scale, corrosion, etc.

Some of the materials that may foul the surface are: Water scale, paraffin wax, etc., silt or mud, coke, corrosion scales.

The transfer rates for clean equipment are usually lowered by as much as 30 per cent by almost insignificant deposits of dirt and when a definite fouled condition exists, the actual rate may be only ten per cent of the rate by the film coefficients. Fouling factors will be presented in Article XIX. The following examples will indicate the vital significance of fouling factors.

EXAMPLE 30. *Exchanger for Wax Distillate and Crude Oil.*

An exchanger is used to cool wax distillate from 500 to 200 deg. fahr. by heating crude oil from 160 to 250 deg. fahrenheit. For the particular conditions, the film transfer rates are approximately as follows:

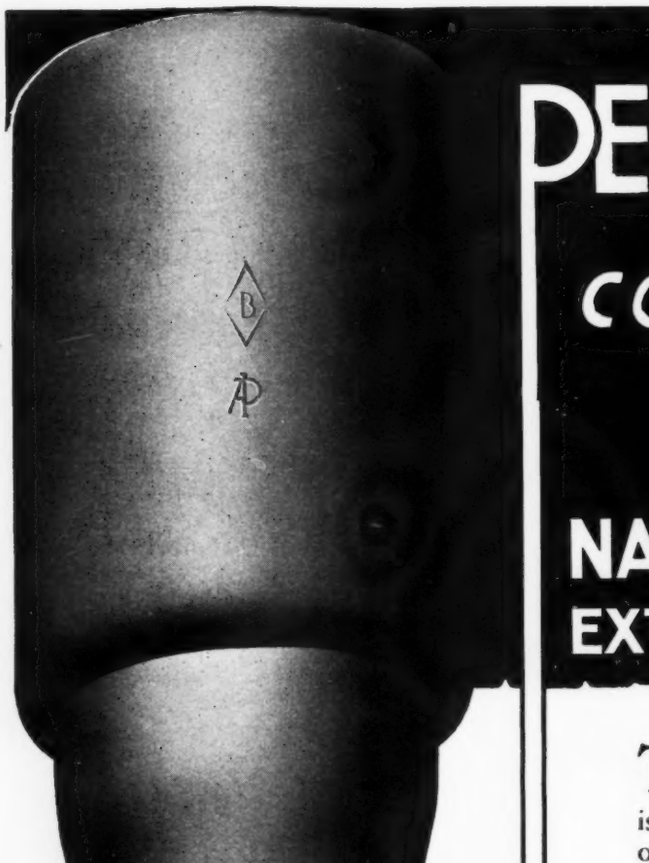
	Film Transfer Rate
Crude Oil	95
Wax Distillate	140

The stocks are clean but wax is deposited from the wax oil, giving a fouling resistance of about 0.026.

$$\text{Overall rate without wax film} = \frac{1}{\frac{1}{95} + \frac{1}{140}} = \frac{1}{.01765} = 56.7$$

$$\text{Actual rate because of wax} = \frac{1}{.01765 + .026} = 22.9$$

*Professor of Petroleum Refining, University of Tulsa.



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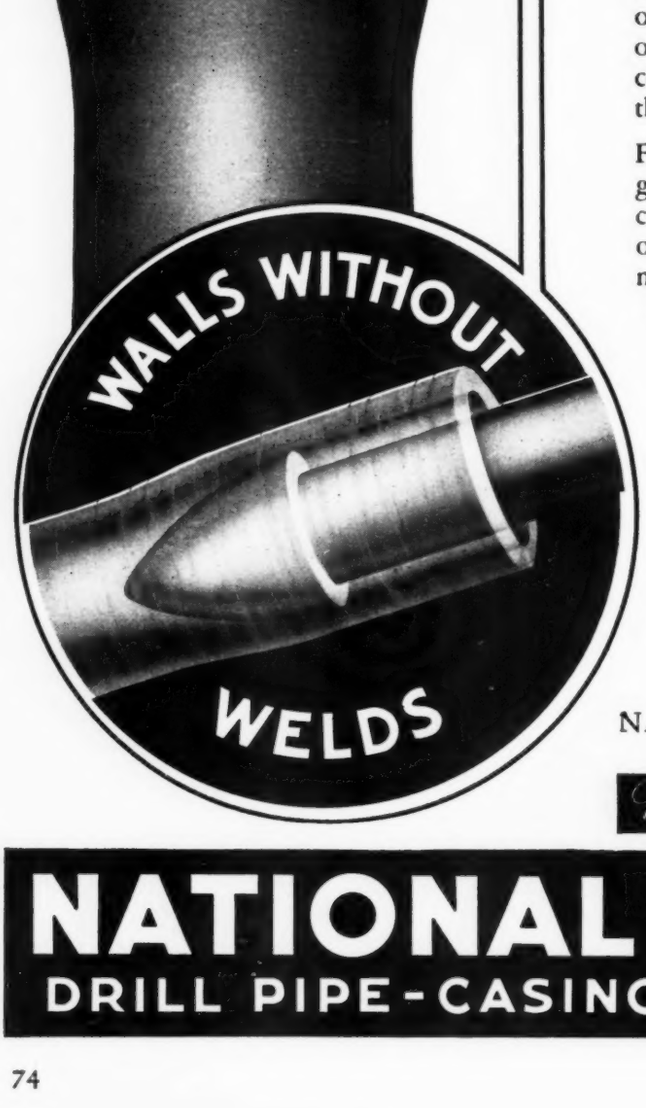

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EXAMPLE 31. *Steam Heater for Water.*

Steam is to be used to heat water in a tubular type of heater in which the water may be circulated through the tubes. Scale is gradually deposited in the tubes until the resistance of the scale amounts to 0.006. The film transfer rates may be somewhat as follows:

	Transfer Rate
Steam	2000
Water	680

$$\text{Clean Overall Rate} = \frac{1}{\frac{1}{2000}+\frac{1}{680}} = \frac{1}{.00197} = 508$$

$$\text{Actual Rate because of water scale} = \frac{1}{.00197 + .006} = 126$$

EXAMPLE 32. *Steam Heater for Fuel Oil.*

A very viscous fuel oil is to be heated by means of a steam coil. The oil circulates only by natural convection and the film rate amounts to only 12. A scale is produced that causes a resistance of the same magnitude (.006) as in Example 31.

$$\text{Clean Overall Rate} = \frac{1}{\frac{1}{2000}+\frac{1}{12}} = 11.9$$

$$\text{Actual Rate due to scale} = \frac{1}{.084 + .006} = 11.1$$

Note that in this example the resistance of .006 had little effect on the clean rate but the same resistance in Example 31 caused a great lowering of the clean rate.

RADIATION

Although radiation is the fundamental way in which most heat is produced, our information concerning radiation is scarce when compared with our knowledge of other ways of transferring heat. In fact, the calculation of the exact amount of radiation that will occur in a commercial equipment such as a pipestill or boiler is almost impossible.

However, a qualitative study of radiation theory is useful in arriving at generalizations concerning this manner of transferring heat. The amount of radiation that occurs is governed by the amount of surface that emits and receives radiation, by the material composing the surfaces and the condition of the surfaces, and by the temperature. The amount of radiation increases as the difference in the fourth power of the higher and the lower temperature. The relation of these variables is described by Stefan's Law:

Q = net heat transferred $= bA\left(t_1^4 - t_2^4\right)$ in which:

A = Area of radiating and absorbing surface
t = Absolute temperature, deg. fahrenheit
b = Radiation constant
Q = B.t.u. transferred per hour.

The absorption or emissivity constant b is dependent on the two materials between which heat is being transferred and, in addition, upon the roughness of the two surfaces. Materials that have a rough or dull finish surface are usually good radiators or absorbers of radiation, whereas polished surfaces usually reflect most of the radiation that falls upon them. Table 22 indicates the radiation properties of several materials.

TABLE 22
Radiation Constants

	b x 10^{-9}
1. Perfect black body	1.72
2. Cast iron, rough or oxidized	1.57
3. Lamp black	1.56
4. Sheet iron, oxidized	1.55
5. Lime mortar	1.51
6. Ceramics ware, unglazed	1.34
7. Copper, polished	.28
8. Field soil	.63
9. Iron, polished	.47

The fact that radiation is so vitally dependent upon the temperature difference greatly simplifies certain calculations because the lower temperature can often be neglected. The amount of radiation that is emitted by a surface at 2460 deg. fahr. is 16 times greater than the radiation from the same surface at 1000 deg. fahrenheit. The following example illustrates the fact that the lower temperature may sometimes be neglected.

EXAMPLE 33. *Radiation and Oil Temperature.*

A pipestill operates with an average flame temperature of 2400 deg. fahr. (2860 deg. absolute). During one operation the oil is at an average temperature of 600 deg. (1060 deg. absolute) when in the radiant section and at another time it is at 800 deg. (1260 deg. absolute).

How will this change in temperature affect the amount of radiation that is absorbed in the two cases?

Case I. Oil at 1060 deg. absolute

$$Q_1 = bA\,(2860^4 - 1060^4)$$

Case II. Oil at 1260 deg. absolute

$$Q_2 = bA\,(2860^4 - 1260^4)$$

$$\text{The ratio of } \frac{\text{Case II}}{\text{Case I}} = \frac{(2860^4 - 1260^4)}{(2860^4 - 1060^4)} = \frac{63510 \times 10^9}{64750 \times 10^9} = .982$$

The radiation when the oil is at the higher temperature is about 98 per cent of what it is when the oil is at 600 degrees. This error is indeed negligible if the other sources of error are considered.

If the lower temperature is neglected altogether for Case I:

$$\text{Per cent error} = \left(\frac{2860^4}{2860^4 - 1060^4}\right) 100 - 100 = 2 \text{ per cent}$$

Thus the lower temperature can be neglected in this case, with an error of only two per cent.

Another useful conception from pure radiation theory is the conception that radiation proceeds in straight lines and that any opaque object casts a shadow into which radiation does not penetrate. As an example, radiation does not penetrate into a bank of staggered tubes for more than a depth of three or four rows. The second row of tubes in the radiant section of a pipestill heater receives only about 53 per cent as much radiation as the first row and if the third row were used, it would receive only about 12 per cent as much as the first row. This explains the fact that more than two rows of tubes are never used in the radiant section and also explains the present trend to use only one row.

In Article XX the application of radiation theory to the particular equipment, the pipestill, will be discussed in more detail.

QUESTIONS

1. Explain the difference between overall coefficients of heat transfer and the film transfer coefficients.
2. What is the meaning of the so-called fouling resistance?
3. If a clean overall rate of heat transfer is 200, what will the actual rate be when the fouling resistance amounts to .005? *Answer*: 100. What if the clean overall rate were only 50? *Answer*: 40.
4. What materials have the smallest film transfer coefficients?
5. What three factors most greatly affect the rate of heat transmission by radiation?

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[1]"Principles of Chemical Engineering," by Walker, Lewis & McAdams. McGraw-Hill Book Co., 1927.
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Elements of Applied Petroleum Production

Article 19

CENTRAL PUMPING POWERS (Continued)

By K. C. SCLATER

IT was stated in last month's article that thorough preliminary work on the layout of a central pumping power would be repaid in the possible operating economies that would result. One of the principal phases of this preliminary work is that of balancing the power.

Balancing the Power

Regardless of the type of power employed, the preliminary procedure in balancing will be essentially the same.

The proper balancing of the power has a very practical significance to the field man. Balancing of the central power neither increases or decreases the expenditure of energy. The purpose of balancing the power is to permit the installation of a prime mover of lower capacity. A properly balanced power will operate smoothly and efficiently and thereby reduce the possibility of frequent breakage and interruption of operation.

The advantage of installing a prime mover of lower capacity lies in the reduction of the amount of energy absorbed by the prime mover itself.

The principal factor to consider in the selection of the site should be concerned chiefly with the uniformity of the load on the power. This uniformity of load is obtained by proper balancing of the power.

The type of wells and their selection will have a bearing on the balancing of the power. In selecting the group of wells to be pumped from the power each well should be studied and its choice for inclusion in the group be based on such important items as:

Pumping load
Rate of production
Pumping characteristics
How often is "pulling" necessary?

The first two items may be determined from dynamometer tests. The rate of production may be so small that the well may not have to be pumped continuously throughout the 24 hours. Certain wells may be heavy pumpers and have to be pulled often. Wells of this type may be irregular in operation and so likely to cause interruptions that equipping them with individual units might be the advisable thing to do.

The ideal solution to the problem would be to locate the power at a point where the resultant of all the forces acting is a positive and constant quantity, if this were possible. In pumping operations, however, the forces acting are not constant but change in magnitude twice during the pumping cycle, the magnitude of the resultant force changing accordingly because of a different combination of forces acting.

Nowels' method[75] of balancing a power is to make up a well weight chart showing lines extending from the power to the wells. Describing his method, he states in part:

"In balancing a power, a well weight chart should be drawn, with lines extending from the power to all the wells. The length of each line depends upon the weight of the well at the power. The forces and their direction in movement at a bandwheel power are subject to the same mechanical laws that govern all forces and may be balanced. A force diagram should be drawn showing the extent of the unbalanced condition in each power eccentric, and the resultant of all forces (well weights) will show the direction or position on the eccentric where additional pull or weight must be added.

"Where two forces are acting in divergent directions, the resultant of these forces may be determined graphically by drawing straight lines to scale in the direction of each force application. If a parallelogram be constructed with these lines comprising two of its sides, and the remaining two sides consist of lines drawn parallel to them, a line may then be drawn as a diagonal connecting the point of origin with the far end of the parallelogram, and will represent the resultant of the two forces. The length of this line should then be scaled, as it represents the amount of force necessary to balance or offset the other two forces. Its extension in the opposite direction gives the direction in which the third force must be applied to cause balance.

"A short-cut to this operation is to eliminate the construction of the parallelogram, and to find where the position of the extreme end of the resultant line would be by simply moving one of the force lines, in its same relative position, and attaching it to the end of the remaining force line. The unattached end of the line just moved is now in the position of the extreme end of the resultant, as described in the first operation. The same procedure is followed in resolving several forces.

"The point of origin, of course, is the power, and each well, as represented by its force (weight) line is plotted parallel to its original position, but attached by its tail-end to the head of the preceding one, the order of attachment of each successive line moving in a clockwise direction. If an eccentric is in balance, the terminal point of the last moved force line will coincide with the point of origin and the resultant of all the forces is zero."

The construction of the force diagrams for power was based on well weights determined by the dynamometer.

Some time later due to increases in amount of water pumped and paraffin, the wells became slightly heavier. This caused the power to be decidedly out of balance, as was indicated on the diagram by the fact that the terminals of the force lines did not coincide with the point of origin.

"By drawing lines between these terminal points and the point of origin two sides of a parallelogram are formed, which, if completed, and the diagonal drawn between the far end and point of origin, gives the resultant of the combined forces necessary to place both eccentrics in balance. The extension of this resultant shows the direction in which these forces must be applied.

"It is preferable to treat both eccentrics separately and for this reason it is necessary to draw a rectangular parallelogram for each, using as two of the sides a line drawn through the ends of force lines perpendicular to this line at the point of origin.

"On knowing the direction of pull needed to balance the power, as given by the diagonal resultant, it remains to choose wells on the heavy side of the eccentric for transfer.

"A convenient method for choosing the proper wells whose direction of pull should be changed, is to draw horizontal and vertical axes through the power or point of origin and to label them plus or minus. The portion of the horizontal axis, to the left of the power is plus, and minus to the right. In the vertical axis, the section above the power is plus, and below, minus. Keeping in mind the horizontal and vertical axes, it is seen that the extension of the resultant for the upper eccentric places it in the lower right-hand quadrant, where both its vertical and horizontal components have values of minus.

"The same procedure may be followed with the lower eccentric in choosing the wells for transfer."

Another method for balancing power, as used by Bossler and Davis,[75] is described as follows: "An axis is passed through the center of the power, which for convenience is treated as an assumed north and south line. A second axis perpendicular to the first at the center of the power is treated as an east and west line. The selection of the direction of the axes is of no importance since a system of forces, such as we have, can have one, and only one, resultant. The direction or bearing of each rod line may be easily determined by measuring the perpendicular distance from each axis to some point on the rod. By using the tension, as determined from the dynamometer reading at the power, as the magnitude of the force, it can be set up into positive and negative latitudes and positive and negative departures, similar to survey computations. The algebraic sum of the positive and negative latitudes and of the positive and negative departures are the components of the resultant, the magnitude and direction of which can easily be determined. When this resultant is zero, the power is in perfect balance. With this method one has the data, in tabular form, before him and if the power is out of balance, he can select a well or wells from this table which have the right components to reduce the resultant to a minimum.

"One of the greatest benefits of this method occurs when a new well is added to, or one taken off a power. In this method the components of the new well are simply added algebraically to the components of the previous resultant, and the balance made as before. Likewise, in taking a well off of the power the components are subtracted algebraically from the resultant and corresponding shifts made to reduce the resultant to a minimum."

Three other methods[82] for balancing a power and determining the most advantageous location of the power are also given. They are described as follows:

"(1) The finding of the most advantageous site by means of the maximum and minimum of the summation diagram of the tangential efforts, which was proposed by S. Nitzberg. Nitzberg proposes to select two points at random among the boreholes that are to be grouped together and assuming the drive at these points in succession, draws a summation diagram of the tangential efforts for each center separately. Each one of these diagrams will determine the direction of the maximum and minimum load on the drive. The directions of the maximum and minimum form an angle approaching 180 degrees. The intersection of the bisectors of the two angles determines the most desired advantageous location for the installation of the drive.

"(2) Finding the most advantageous location by means of the force polygon, proposed by N. Geyshtor, engineer. Geyshtor assumes that the drive is in a state of static equilibrium and proposes to make a cardboard funicular polygon of all the efforts acting on the drive. Instead of the cardboard polygon, make use of a closed polygon inscribed within a circumference. The sides of this polygon will determine the direction of the drives from the fields.

"(3) Finding the most advantageous location by means of balancing bore holes in couples, proposed by A. Danyilovich, engineer. Danyilovich proposes to join every two bore holes in a certain order, to balance them between themselves and to construct the central power accordingly—somewhat like a multiple-beam scale.

"Although these three methods have each been worked out in detail, still no comparative appraisal has been made of the results of the calculation of an existing field installation in accordance with these three methods, and no one has brought out the comparative advantages offered by each of them. An analysis of this kind, based on a practical example, might serve as aids to field engineers in the solution of every-day practical problems."

QUESTIONS

1. Explain the purpose of balancing a central power.
2. Why is it important to consider balancing of the power in connection with the choice of a site for the power?
3. What economies are effected in a properly balanced power?
4. Name some of the important pieces of information that should be known about the individual wells when balancing a power. How is this information ascertained?

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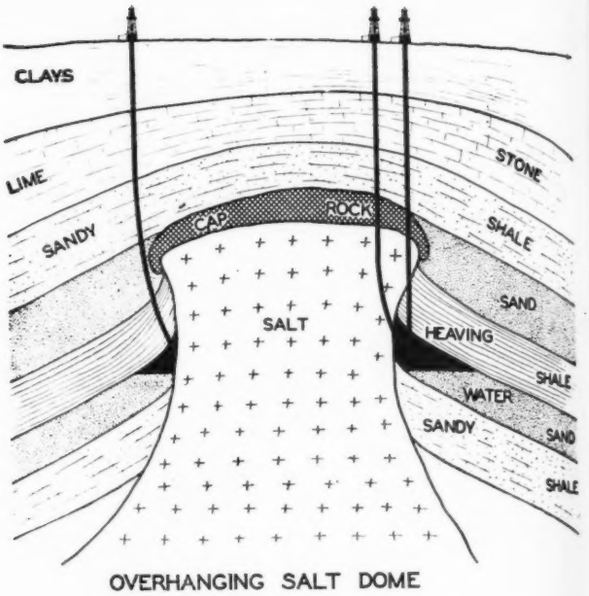
Directional Drilling . . .

A Means of Reaching Legitimate Bottom-Hole Locations Where Adverse Conditions Prevail

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles, Calif.



OVERHANGING SALT DOME

THE control of the direction that a well takes throughout its course from the surface of the ground to the objective productive (or hoped-to-be-productive) zone can, and should be, a legitimate operation. The mere fact that some operators have used directional drilling for illegitimate purposes should not condemn the practice. There have been some recent exigencies that have called attention to the use of this practice by rather spectacular, but eminently sound, applications. The misuse of directional drilling has, fortunately, been brought to public attention through court action. There is every reason to believe, however, that the legitimate use of directional drilling will increase and that it will aid greatly in spacing wells properly on the productive zone instead of spacing them on the surface with the hope that the bottom of each well will be somewhere near where it was intended.

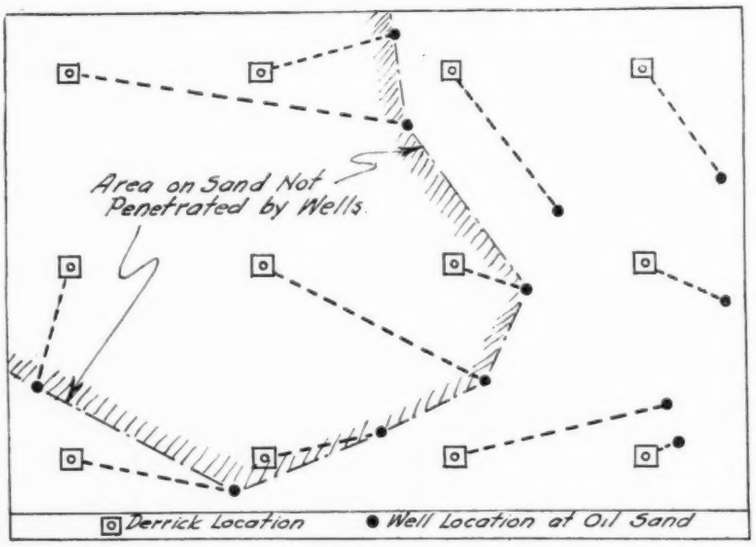


Fig. 1 (Left) Shows how points at which the producing horizon is penetrated by wells seldom conform with the uniform spacing of the wells on the surface.

Fig. 2. (Above) Shows how directional drilling avoids the necessity of drilling through the caprock to reach the producing horizon in a salt-dome field.

Strictly speaking, keeping a well vertical is directional drilling. While this may be a somewhat negative action in that it merely keeps the hole from being crooked, a hole kept straight is one that is definitely aimed at a predetermined point underground. A little nearer to the popular conception of directional drilling is the bringing back to a point beneath the derrick of a hole that has wandered away from the vertical. However, if the direction were controlled and a knowledge of the direction obtained by periodic underground surveys, the extra time and expense necessary in bringing the hole back could be avoided.

Many old wells, so carefully spaced on the surface, have been surveyed and found to have wandered far from the straight and vertical. In some cases, areas of considerable extent have been left unpenetrated; areas that should be tapped for the effective development of a lease. An example that is self-explanatory is illustrated in Fig. 1. In this case, one or two wells can be selected for surface locations to drill into the untapped area and, after production is abandoned from the present producing area of these wells (an area that is well taken care of by other wells), holes can be directed to the proper locations on the sand to complete its development. The drawing given is hypothetical, it is mild compared to some actual conditions of a similar nature found in some of the California fields.

Direction is controlled both with and without deflecting tools. Sometimes deflecting tools are necessary; sometimes they are preferred. The condition of the hole and the character of the formations are of vital influence; and so is the experience of the operator. The whipstock and the knuckle joint have their definite applications. If the well is to be kept vertical, only proper drilling control should be necessary with due attention being paid to the weight carried on the bit and, as has been found by some operators, to the speed of rotation. The matter of sidetracking and similar contingencies will, of course, offer problems that require more than straight-drilling procedure.

Underground surveys are in most cases necessary. Always they are desirable in straight-hole drilling even though not made as frequently as when a hole is being carried at an inclination. For directional drilling, periodic surveys are indispensable; but their frequency depends on too many conditions

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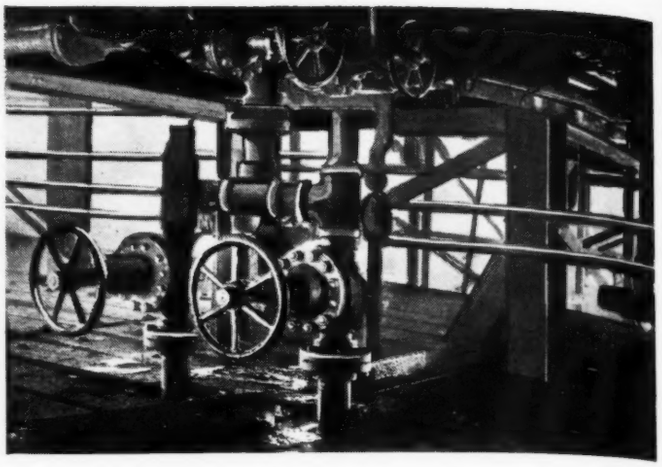


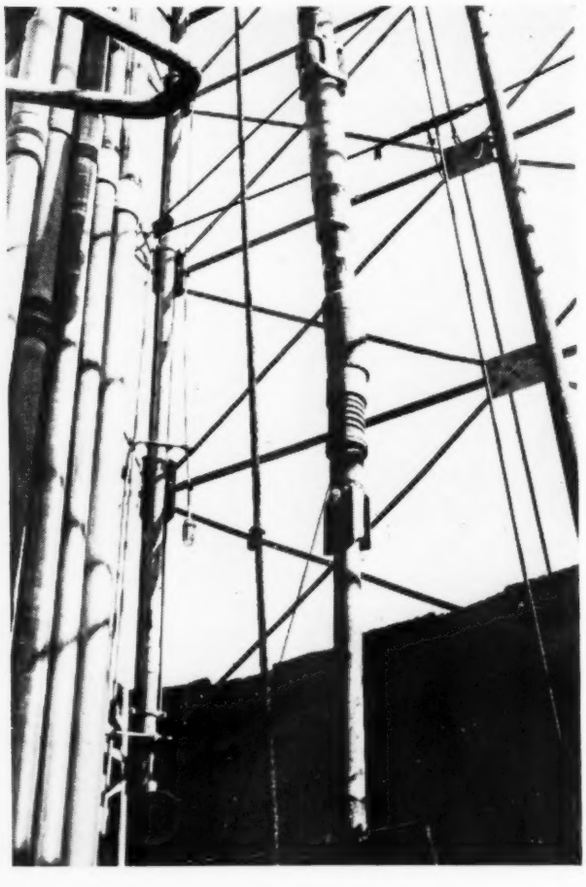
The Christmas tree set up on a platform below the pier deck for producing the first well while the others were being drilled. All three were hooked up similarly for natural flow and for gas-lift before they were put on the pump

to provide a rule. The single-shot survey instrument giving both the inclination and the direction of open hole at any point while drilling is now so widely used that surveys made with it have become almost general practice in many localities. Certainly when a hole is aimed for a definite objective not directly below the derrick, the use of such an instrument is necessary.

The interest in directional drilling where wells are diverted from the vertical and directed along a specific course to attain a definite purpose was evident at a meeting of the Los Angeles Basin Chapter of the American Petroleum Institute held in Long Beach on March 12, 1935. Many phases of the subject were treated including the legality of operation in some of the California areas.

The meeting was opened by a discussion of directional drilling to overcome the hazards produced by wild wells. The operations used on the Conroe crater and in controlling the Seeligson well, both in Texas, were described by H. John Eastman, president of the Eastman Oil Well Survey Company. Complete details of these jobs have been previously published.

Continuing the discussion, the advantage of directional drilling for salt dome development was brought out. Referring to the illustration, Fig. 2, of an overhanging salt dome, it can be seen that the vertical well to the extreme right must pass through the cap rock, then through the salt, and finally through heaving shale to reach the oil sand. Where heaving shale causes considerable trouble, it may be wise to locate the well a little to the left and, by directional drilling, miss the heaving shale entirely.



This type of knuckle joint, which is shown being run into a California well, has been found efficient for use in directional drilling.

In some salt domes, the cap rock is badly fissured and broken up and frequently causes loss of circulation and other troubles. To meet this condition with directional drilling, the location of the well may be made as shown on the extreme left of Fig. 2 and the course of the hole directed toward the oil sand after it has passed below where the cap rock lies. This also has the advantage of avoiding the drilling through salt, which is sometimes drilling of an undesirable kind.

In the discussion of the methods used for well deflection and control, it was brought out that deflecting tools can usually be used to advantage and will probably save considerable time in conducting the operations. In the Long Beach field, California, the use of such tools is not so necessary since the formations are so well known. Different types of bits have been found to have definite tendencies in deflection. The drag bit will generally go to the right and a wheel type bit will tend to go to the left. In the Oklahoma City field where rock bits are used, it was stated that the wells tended to wander to the left. The hard formations in this field have also been found to leave steps while using directional drilling and that it is difficult to hold the well to its objective.

The history of the drifted wells in the Huntington Beach field was given at the A.P.I. meeting by R. H. Garrison, consulting petroleum engineer. It is asserted that there are 34 wells "bottomed" within a 20-acre area under the Pacific Ocean off Huntington Beach where four wells would probably handle all the production. The vertical depth to the sand is from 3550 to 4120 ft. but the measured depths of the wells are considerably more than that. The greatest angle recorded was 78 deg. from the vertical.

Several of the wells, of course, met underground. It is remarkable, however, how well the casing ran into most of the holes except where there were bad kinks. In starting these wells off, the original direction was most frequently given by a whipstock. The direction was then controlled by the weight carried on the bit with slow rotation. The inclination and direction of the hole was measured at frequent intervals.

Three Wells Drilled From One Location

The great expense attending the drilling of wells from piers on tidewater leases can readily be understood. The size of such leases is sometimes quite extensive and although piers may extend as far as half a mile from the shore line, wells cannot always be

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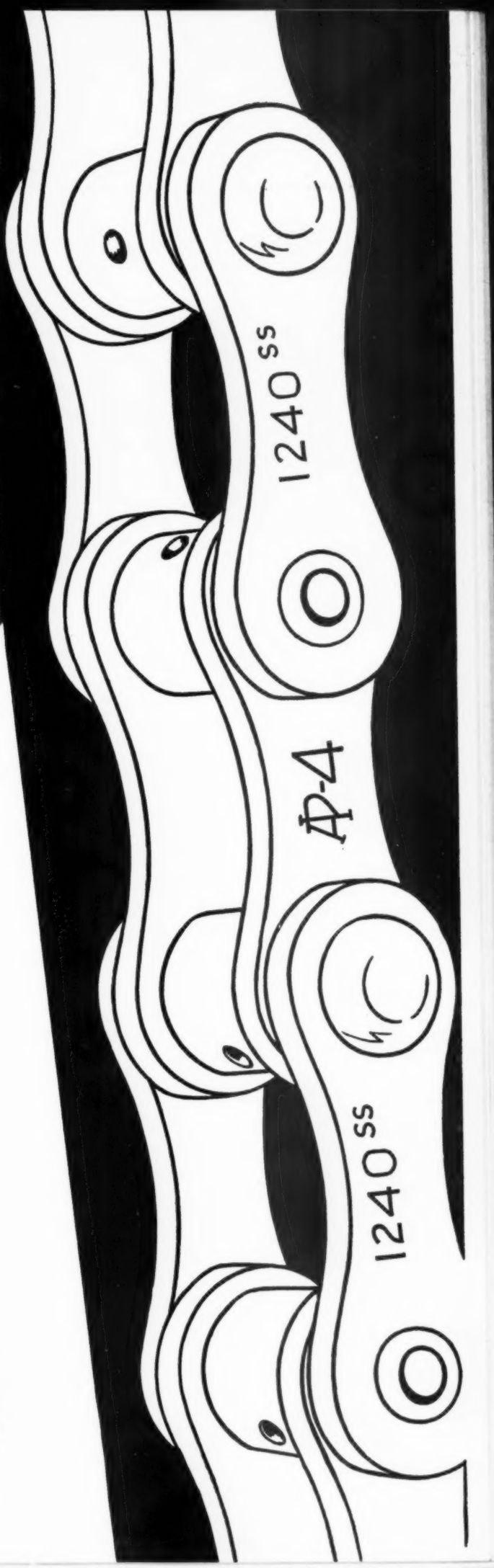
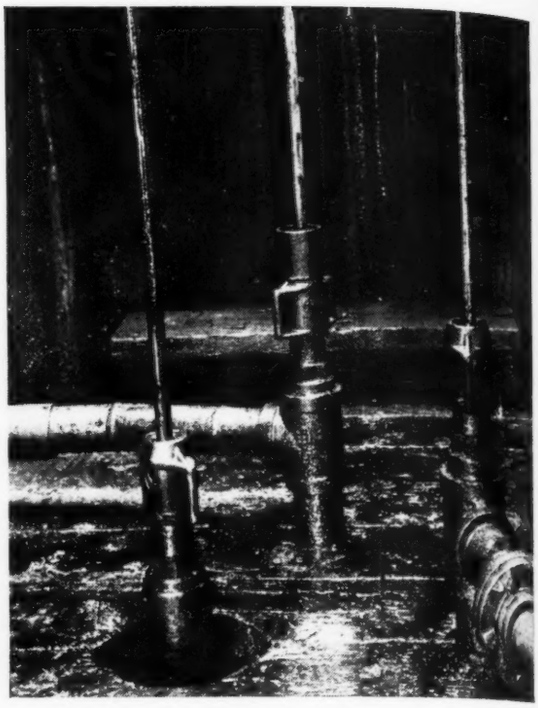




The stuffing boxes and polished rods of the three wells on the pump

spaced as closely as might be desired. Controlled directional drilling can here be used to eliminate the necessity for additional pier construction in order to penetrate the productive zone at proper locations that could not be drilled economically with vertical wells. An interesting example of this described by W. C. Whaley, vice-president of the Barnsdall Oil Company, was the drilling of three wells from the one location at Elwood Field, California.

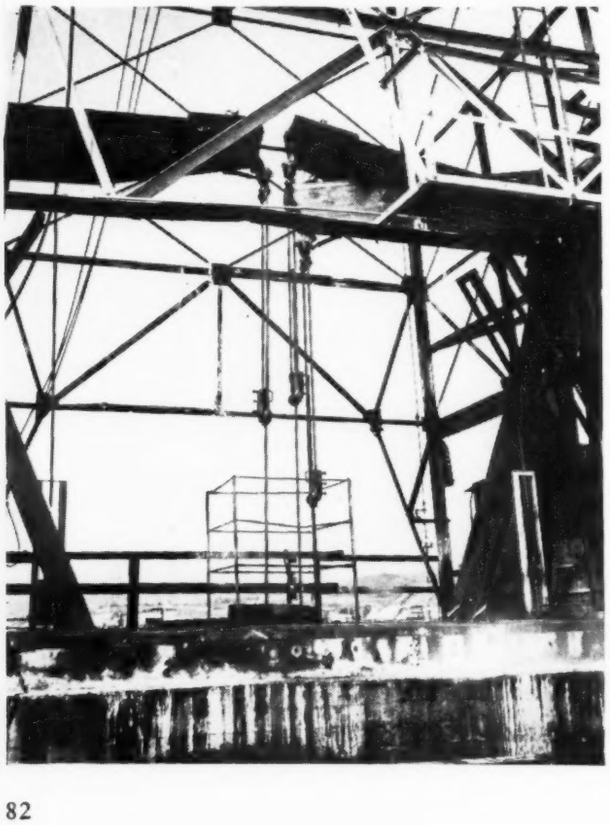
The greater portion of the productive area in this field lies beneath the Pacific Ocean and the location selected for the operation was at the outer end of one of the company's piers. The development of the method used and the supervision of the work was by the engineering department of the Barnsdall Oil Company. All the work was carefully planned in advance and no trouble was experienced in putting down any of the three holes.

A 49-in. conductor was set in the shale 76 ft. below the derrick floor when the foundation was constructed, with the top of this conductor located 20 ft. below the floor. When drilling was started, 79 ft. of 18⅝-in. 84½-lb. slip-joint casing was welded together and driven into the shale against the southwest side of the conductor pipe. The bottom of this casing was then at 81 ft. and the top was pulled over toward the drawworks to form an inclination of 2¼ deg. from vertical. The crown block and drawworks were set in their normal position but the rotary table was placed two ft. toward the drawworks and made the 18⅝-in. casing line up with its center. The hole was then drilled to 178 ft. with a 17¼-in. fishtail bit on 6-in. drill pipe.

At this point the rotary table was moved back to its normal position and the 18⅝-in. conductor pipe pulled over to line up with the center of the derrick at the top of the table. The hole was then drilled to 500 ft. with a 17¼-in. disc bit on 6-in. drill pipe and with all the weight being carried on the bit. A string of 13⅜-in. casing was run in and cemented, the cement extending up to the bottom of the 49-in. conductor. The 18⅝-in. casing was stripped off and the 13⅜-in. pulled over against the side of the 49-in. conductor pipe in line with and 1.10 ft. from the center of the derrick on the side opposite the drawworks. The 13⅜-in. casing was then clamped to two 20-in. I-beams that had been set at right angles to the pier line. The 49-in. conductor had 8-in. H-beams set around the top in the form of an octagon and it was upon these that the 20-in. I-beams were set and bolted in place. The arrangement was such that additional beams could be bolted on at right angles to these beams for the other two wells to be drilled later.

The crown block and rotary table were then moved from the normal position to a point 1.10 ft. farther away from the drawworks that was directly over the 13⅜-in. casing, which was now vertical for the first 78 feet. The hole was then carried on down to the top of the producing sand and kept in the direction desired during drilling by means of periodic surveys. The survey readings were made with a single-shot instrument that recorded both direction and inclination at each point where the readings were taken. Where found necessary, the instrument was run as frequently as every 10 or 15 ft. and never at greater intervals than 75 feet. In this way the well was directed to the place where it was desired to strike the oil sand so that well-spacing at the sand would make for proper development of the company's lease.

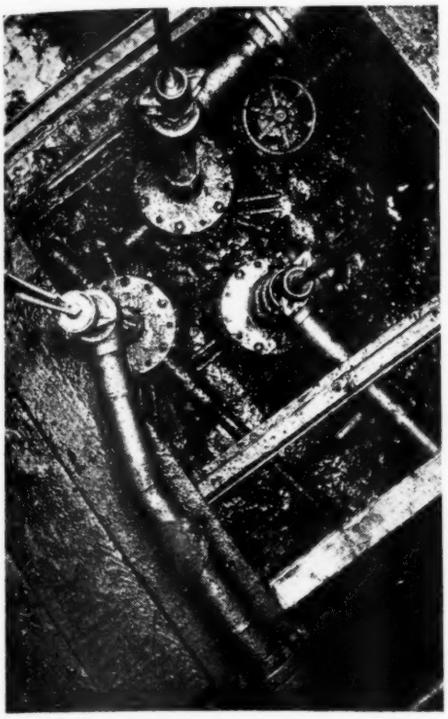
A string of 10¾-in. casing was cemented on top of the sand and this casing landed immediately on top of the 13⅜-in. in order to conserve space. The well was then deepened into the producing zone and the liner and tubing run in the usual manner. The tubing was landed in the tubinghead set immediately on top of the 10¾-in. companion flange. A temporary Christmas tree was set up on the derrick floor until production was proved and until such time as the second well was started.



The ends of the beams while the wells are being pumped. Any length of stroke or any speed can be used on each well regardless of the stroke and speed of the other two wells

The Second Well

Preparatory to drilling the second well, a platform with seven



Looking down at the three tubingheads of the wells producing from the one location on a pier in the Elwood field

ft. of head room was constructed below the pier deck and opposite the well foundation. A hole was then cut through the foundation in such a position that it would line up with the tubinghead on No. 1 well, clear the H-beams in the foundation and allow room for drilling the other two wells. Through this hole, 4-in. lines were run to both the tubing and casing and connected to a Christmas tree built on the platform, as shown in an accompanying illustration.

The 18⅝-in. conductor pipe used for No. 1 well was first driven three ft. into the shale against the side of the 49-in. conductor with its bottom 0.6 ft. toward the drawworks and one ft. to the left of the center line of the derrick. The top of this pipe was then pulled over and clamped in a northwesterly direction, parallel to and against the side of the 20-in. I-beams used in landing No. 1 well. This made the inclination of the 18⅝-in. pipe about two degrees from vertical. The rotary table was moved 0.60 ft. toward the drawworks and 1.80 ft. to the right of the center line of the derrick, with the drawworks also moved the same distance to the right. The crown block was moved 0.6 ft. toward the drawworks and the hole drilled to 156 ft. with all weight carried on a 17¼-lb. bit.

The 18⅝-in. conductor was then pulled over to line up with the center of the derrick at a point 0.6 ft. toward the drawworks, the rotary table moved over the top of the 18⅝-in. pipe and the drawworks placed in normal position. Drilling was continued to 500 ft. where a string of 13⅜-in. casing was run and cemented. The 18⅝-in. conductor pipe was then stripped off and the 13⅜-in. casing pulled over to its final position and clamped to 20-in. I-beams. The center

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Photograph below shows sample record made by the H-K. Photographs at right show SURWEL *and* SYFO *Clinographs.*

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of the 13⅜-in. was now 1.20 ft. to the left of the center line of the derrick and 0.6 ft. toward the drawworks. The crown block, drawworks, and rotary table were therefore moved 1.20 ft. to the left.

The well was drilled to the top of the productive zone in the same way as No. 1 and kept in the predetermined direction by means of survey readings. A string of 10¾-in. was cemented on top of the sand, and liner and tubing run as in No. 1 well. A Christmas tree for production of this well was also set on the platform below the pier deck but the hole made through the foundation for the 4-in. lines to tubing and casing was below the platform level in order to keep space clear for access to No. 1 well fittings by carrying the No. 2 well lines below the platform floor.

The Third Well

For starting the third well, a 4-in. offset was put in the bottom 13 ft. of the 18⅝-in. conductor pipe. This was then driven three ft. into the shale with the bottom against the side of the 49-in. conductor and with the offset pointing in a northwesterly direction at an inclination of about one degree and 45 minutes. The crown block and rotary table were moved 0.6 ft. toward the drawworks and 0.75 ft. to the right of the center line of the derrick, the drawworks also being moved over the same distance to the right.

After drilling to 500 ft. with 17¼-in. fishtail bit and reamers, 13⅜-in. casing was run and cemented. The 18⅝-in. pipe was then stripped off and the 13⅜-in. casing was pulled over against the 49-in. conductor, or 1.10 ft. to the right and 0.6 ft. toward the drawworks. With the casing there clamped, the 49-in. conductor was cemented up to the bottom of the cellar.

The crown block, rotary table, and drawworks were moved 1.10 ft. to the right of the center line of the derrick and the crown and table placed 0.6 ft. toward the drawworks. Drilling was then continued and No. 3 well completed the same as the other two wells. The flow lines, however, were taken out through the cellar opening.

Pumping Three Wells From One Location

The three wells were produced with gas-lift for some time but were recently put on the pump. As shown in the accompanying photographs, the wells form an isosceles triangle with each being two ft. from the other two. One is on the center line of the derrick and the others are equi-distant from that line. In putting the three wells on the beam, the Samson post for one unit was set farther over the edge of the foundation than is usual practice. The other two Samson posts were built together with 3½-ft. centers. The arrangement, as illustrated, allows a clearance of four ft. between wristpins at a 72-in. stroke when the crank is horizontal and the wristpins nearest the polished rods.

Each pumping unit is driven by gas engine and is a separate operating unit. While the surface outlets for the oil are within two ft. of each other, these are three separate and distinct wells that are taking oil from locations properly spaced on the sand. The operation shows the value of controlled directional drilling in spotting wells on the sand to obtain efficient lease development that would be rather costly by vertical drilling.

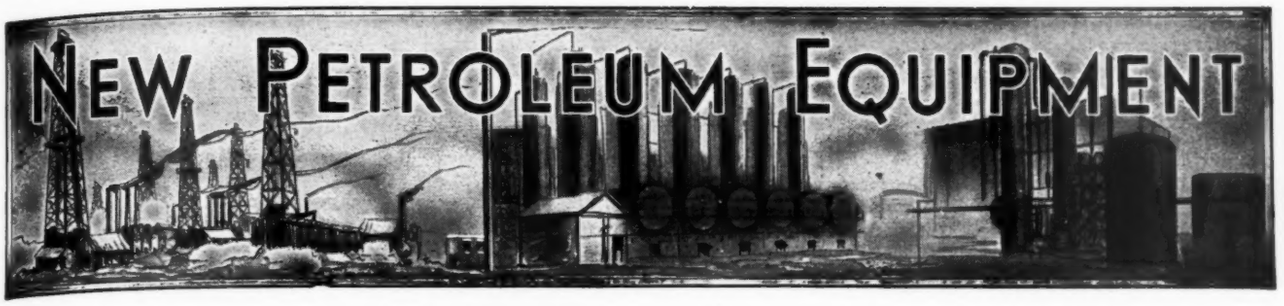
Legal Aspects of Deflected Wells

There have, unfortunately, been cases in California where wells have been deflected by directional drilling so that the bottom of the wells were outside the boundaries of the operator's property. Considerable interest was, therefore, evinced in the general views on trespassing wells as presented by M. A. Kline, an attorney associated with the firm of Andrews and Andrews of Los Angeles, at the A.P.I. meeting held in Long Beach. Briefly considered by Mr. Kline were the legal aspects of: (1) the ownership of oil and gas in place; (2) oil and gas lessee's rights against trespass; (3) character of suits against trespass; (4) the problem of proof; and (5) enactment of legislation to regulate the practice.

Both the civil and criminal problems involved were touched on in the discussion and the extent to which court action has already advanced was indicated by a recent ruling regarding a well drilled at Mt. Poso, California. The District Court of Appeals here sustained indictments against operators who were charged with deflecting a well into an adjoining lease belonging to another company. In this case, the demurrer of the defense had previously been sustained and the indictments thrown out of court. The state appealed and the appellate court overruled the judgment, reinstating the indictment and ordering the case back to trial.

Mr. Kline closed with the remarks that there is nothing new or novel in the principle of law involved; it resolves to a matter of honesty. He feels that if a well is not drilled within the boundaries of a property with the tools and instruments now available and with the experience attained by the petroleum industry, the operator either does not want to or does not know how. It is hoped that any doubt about ownership will be removed by clear and unequivocal legislation. There are many legitimate problems to be met by directional drilling, and it is regrettable to have it given a "black eye" by illegitimate use.

Three wells tapping the sand at different locations below the ocean are producing at this location on the pier, Elwood field, California



Featuring Hercules Products

THE Hercules Tool Company, Kennedy Bldg., Tulsa, Oklahoma, manufacturers of oil well specialties, are featuring patented tubing and casing heads, as well as other items for well hookups (complete line will be on display at Booth 121, Oil Equipment and Engineering Exposition, Houston, Texas).

Hercules casing heads, with slips that apply the packing above, permit repacking without lifting the inside string or disturbing the well hookup. Special steel and rubber packing rings are compressed down on top of the slips by means of a split steel packing nut. Outside at the top is an A.P.I. casing thread for use of overshot or blowout preventer. Two 3-in. side outlets are provided. Type B is a high-pressure forged steel head for wells up to 7000 lb. pressure. Type A is of similar design but of cast steel for wells up to 3000 lb. pressure.

Hercules tubing heads are characterized by the same general features as the Hercules casing heads, slips or mandril being used to suspend the tubing with the same method of overhead packing. Types C-3 and OC are very similiar but the OC type has the same outside diameter as the casing, permitting the running of tubing catchers or anchors and other devices without changing or stripping connections. These types are of forged steel tested for pressures up to 5000 pounds.

The type L is designed for tubing wells under presure with the use of mandril and blowout preventers screwed on to the tubing head. Hydraulic packing compressed by a packing nut packs off the well between the tubing and the tubing head. This packing may be replaced without disturbing the well connections or danger of tubing being blown out of the well.

Hercules pumping well hookup, illustrated, shows the Hercules tubing hanger and upset pumping and flowing tee in use with upset tubing and an ordinary casing head. The Hercules tubing hanger utilizes slips to support the tubing, a rubber packing ring being compressed firmly down on the slips by a packing nut to give a seal-tight pack. Body is of forged steel.

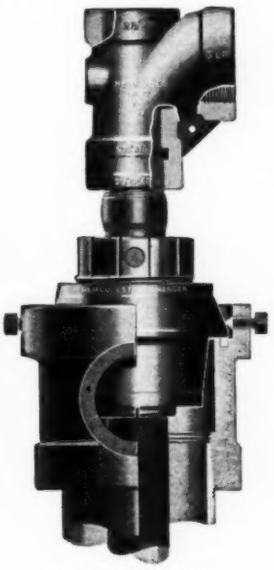
The Hercules combination thread tee with both upset and regular threads on the bottom, eliminates cutting off upset threads of tubing to make a connection or use of a reducing nipple. Ninety degree side outlet is 3 in. in diameter on 2½-in. tees. There is a 1-in. opening on back side for bleeder or pressure gauge. Furnished with 10 or 11½ threads—also with British Standard threads.

The Hercules flow head is for use on wells which are flowed through the annular space. They are similar to Hercules tubing heads except that bodies are made with either a 90-deg. or 45-deg. side opening which is the same size as the casing on which they are to be made up. On opposite side there is either a 2-in., 3-in. or 4-in. opening. The body has an oil saver top. Made of electric cast steel test for 3000 lb. pressure.

The Hercules tubing anchor is a bottom-hole tubing support which eliminates parted tubing trouble and is positive assurance against dropping tubing while it is suspended or being pulled, according to the manufacturer. Three friction springs, each with two friction surfaces, give double assurance of anchor operation. Anchor is set by turning tubing one-third turn to left, which places slot pin in vertical slot, then lowering body of anchor into the cage and slips, thus forcing the latter into contact with the casing walls. The anchor can always be controlled at the casing head and can be raised or lowered at will, making it adjustable to fluid pumping level.

Type B
High Pressure Forged Steel Casing Head with Mandril

O. C. Type Forged Steel Tubing Head



Hercules Pumping Well Hook-up

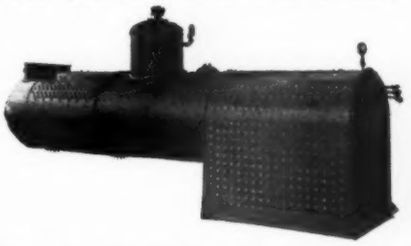
Lucey Oil Country Boiler With Rivetless Firebox

LUCEY PRODUCTS CORPORATION announces the new Lucey Oil Country Boiler with Rivetless Firebox, manufactured by Lucey Boiler and Manufacturing Corporation at Chattanooga, Tennessee.

Although it includes several new and distinctive ideas in boiler construction, the greatest feature is the elimination of all rivets from the firebox wrapper. By welding the firebox wrapper all around, all overlapping joints and troublesome rivets are eliminated, allowing the wrapper to be of uniform thickness throughout, permitting even heat transfer.

The new boilers have 84-in. long firebox, of the open or dry bottom type. The mud ring is tested carefully, caulked and then welded throughout.

The manhole is located directly over the firebox tube ends instead of ahead of the dome as is the general practice. The advantage of this feature is obvious. The tube ends, where most scale and foreign matter collect, are made easily accessible for cleaning. The smoke box door is air-tight, permitting better draft condition.



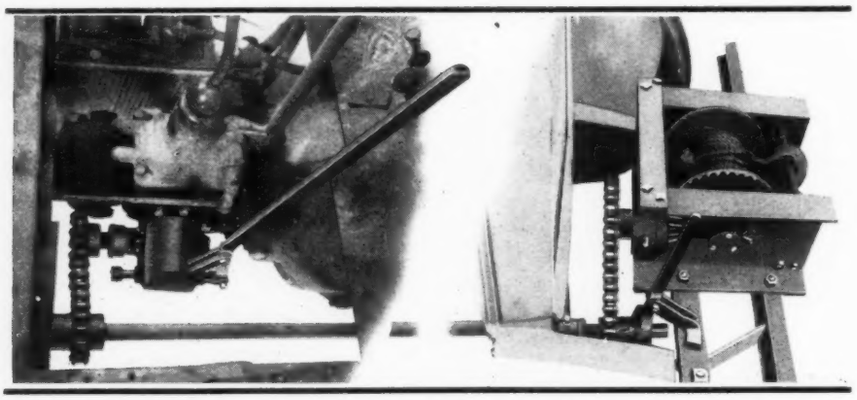
Vertical tube arrangement permits easy cleaning.

Although rated by the manufacturers on the standard basis of one hp. to each ten sq. ft. of heating surface (based on area exposed to products of combustion) it is claimed that, due to added efficiency gained from features of design, one hp. to eight sq. ft. of heating surface would be a more equitable rating for these new boilers.

Other features and details of construction may be obtained by writing for Bulletin No. 141.

Koenig Iron Works Announce Auto Winch

AN auto service winch for quickly pulling cars or trucks from mud, sand or road-side ditches, is announced by Koenig Iron Works, 2214 Washington Avenue, Houston, Texas. It is mounted on the bumper and operates a cable, with hook, up trucks that are not factory equipped. An auxiliary hand lever at the winch engages the drum when ready for operation. An auxiliary power take-off lever for operating the power winch is adjacent to the regular gear-shift lever, and does not



for anchoring to a tree, fence post, or screw anchor in event no natural anchor is convenient.

When the car or truck is stuck the driver unreels the cable, hooks on, and operates the winch at a gear ratio of 17 to 1, pulling the vehicle up to the anchor point.

This service winch is made in power type, run from a power take-off from the transmission, and hand type, operated with a ratchet winch by the driver. The power take-offs are manufacturered by Koenig Iron Works for passenger cars and pick- interefere with regular driving operation.

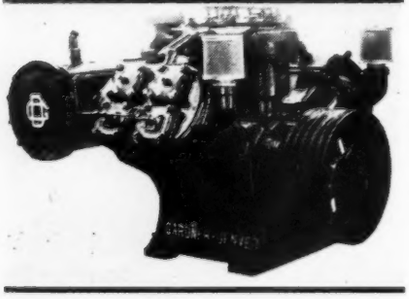
The winches are bearing equipped, and frame-work in which the drums are mounted is of heavy channel iron, welded. Both types are equipped with a "dog" to control the drum rotation at any 5/8-in. point.

The auto winch serves also as a truck utility winch, and may be mounted behind the cab for loading or unloading, or for moving heavy equipment on lease location.

Further details will be furnished by the manufacturer upon request.

Gardner-Denver Compressor

IN keeping with the modern trend towards more delivered air, lower power consumption and longer compressor life, Gardner-Denver engineers have developed a new six-cylinder, two-stage, water-cooled compressor embodying distinctive features. These features, Gardner-Denver officials state, provide more



delivered air, with a resultant saving in power cost.

An outstanding departure from conventional compressor design is the use of four small-diameter low-pressure cylinders instead of two large ones, this construction permitting the use of small, lightweight pistons and considerably reducing the inertia loads. The use of two pairs of low-pressure water-cooled cylinders provides lower air temperatures than previously obtained in small vertical compressors, with corresponding saving in hp., the manufacturers state. By water-cooling the cylinder walls, lower wall temperatures are obtained, with better lubrication and longer life. Distortion of cylinder walls from heat is eliminated, and, in addition, the compressor operates independently of atmospheric temperatures.

These six-cylinder compressors, it is stated, adequately meet the need for more compact machines having efficiencies comparable to those of large two-stage horizontal compressors of the same capacity.

Mountings include motor mounted on shaft; V-belt to electric motor, Diesel or gasoline engines; or direct connected through flexible flywheel coupling to motor and engines.

Additional information can be obtained from the Gardner-Denver Company, Quincy, Illinois.

TAG-Macbeth A.S.T.M. Daylight Lamp

IN accordance with new specifications adopted in June, 1934, by the A.S.T.M., the C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York, offers a new daylight lamp for color determinations that gives an illumination closely approximating ideal daylight conditions for color tests. This new, adjustable-type TAG Macbeth Daylight Lamp is suitable for use with the TAG Saybolt Chromometer, A.S.T.M. Serial D156-34T; the TAG Union Colorimeter, A.S.T.M. Serial D155-34T and D218-34T; also the TAG Robinson Colorimeter.

The company states that its Union Colorimeters are now equipped with this new daylight lamp, attached by means of an adjustable bracket. Where Union Colorimeters are now in use, the old lamp should be removed and a new lamp procured in order to meet standard specifications, it is stated. In addition, the specifications require the insertion, in the Union Colorimeter, of a piece of new flashed opal diffusion glass which TAG can now supply to bring the instrument up to date.

Emergency Carbide Light

A NEW carbide police emergency light weighing only 40 lb. when fully charged, and which burns for three hours, giving 8000 candle power, has recently been announced by the National Carbide Sales Corporation, Lincoln Building, New York City. Announced as a police emergency light, it has many other applications in the municipal, aviation, railroad, and construction fields.

The reflector is mounted on a universal swing joint, so that the light may be shifted to any angle and may be easily folded down for carrying by a convenient

handle above the carbide hopper. The unit is three and one-half ft. high when extended for use, and 28 in. when folded.

A one and three-quarter pound charge of carbide placed in the hopper is sufficient for more than three hours. The light may be operated intermittently, as needed, without the waste of any of the charge. By throwing a lever, the carbide is released a few grains at a time into the water tank below, and the rate of feed of the dry carbide is regulated automatically by the gas pressure. The light may be shut off by throwing the lever back to locked position. The tank is made of 18-gauge sheet steel, hot-dipped in lead after the tank is welded.

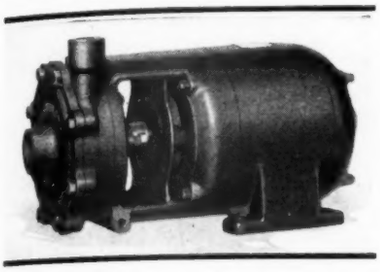
No spilling results if the light is turned over. It will go right on operating when set upright.

Worthington Announces An Advanced Development of Its Two-Stage Centrifugal Pump

AN advanced development of its two-stage Monobloc centrifugal pump is announced by the Worthington Pump & Machinery Corporation, of Harrison, N. J. The low power requirements and simplicity of this modern unit make it especially applicable to all services requiring small capacity and medium discharge head, the manufacturers state.

The casing, designed to withstand 150 lb. pressure, is bolted directly to the motor frame without an intermediate distance piece, thus eliminating the necessity for a baseplate.

Attention is called particularly to the unique impeller design, which is a unit construction consisting of two enclosed type impellers cast back-to-back, so that the overhung weight is actually no greater than that on a single-stage pump. The impeller, which is keyed, is held firmly to the shaft by an impeller nut and the shaft sleeve, also keyed, is a separate, renewable part.

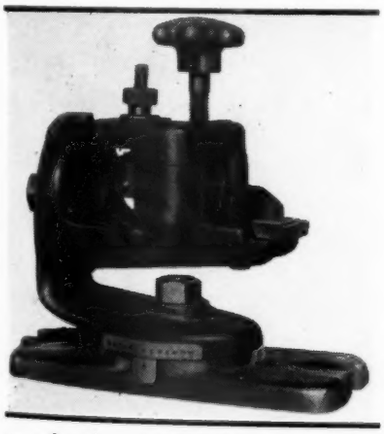


Reliability is attained through the use of a motor that features oversize grease-lubricated ball bearings, the company points out. In this Monobloc unit, which follows closely the design of Worthington's larger pumps, the impeller is mounted directly on the motor shaft, eliminating the additional space and weight of a coupling. This unit can be mounted vertically or horizontally, with full assurance of satisfactory performance in either case, it is stated.

Advanced features of design, adopted with a view of combining high efficiency and dependability, appear in these new models. The pump has steep head capacity characteristics and is recommended by the makers as ideal for air conditioning installations, refrigeration service, boiler return and chemical process work.

Tap Chaser Rake Grinding Attachment

THE Landis Machine Company, Tap Division, of Waynesboro, Pennsylvania, has placed on the market the fixture or attachment illustrated herewith for use



poor threads and short life. It is always important that the rake angle be ground suitably for the material being tapped, as in regrinding or sharpening the chasers used in their Landis Style LT and Style LM Receding Chaser Collapsible Taps.

The correct grinding or sharpening of collapsible tap chasers is very vital to the efficient performance of these tools. Improperly ground chasers frequently mean different rake angles are required for the different materials.

The attachment is composed of three main parts; first, a base, adapted for fastening to the table of most makes of tool and cutter grinding machines. Attached to the base is a second part, the swivel bracket, adjustable in a horizontal plane in relation to the base. The bottom part of the swivel bracket is graduated to permit obtaining the desired degree of azimuth, the angle at which the chaser is set from the parallel. The third part of the attachment is the vise base, which is clamped to the swivel bracket and which holds the chaser while being ground. The vise base can be rotated in the vertical plane and securely clamped at any angle as determined by graduations on the top of the swivel bracket. This permits setting the chaser at the proper elevation for grinding the gun tap in the throat section of the rake.

The vise base is provided with a milled flat that will accommodate all sizes of tap chasers. The chaser is held in place by an adjustable spring clamp and locked with a hand screw.

The attachment is suitable for grinding all size chasers employed in the Landis Style LT Collapsible Taps, the Style LM Receding Chaser Collapsible Taps and also those employed in the Victor Collapsible and Receding Chaser Taps formerly manufactured by the Landis Machine Company or the Victor Tool Company.

The Same FLUID PACKED PUMP is efficient for *LIGHT OIL as well as HEAVY OIL!*

Here's the Reason . . .

The only packing in a Fluid Packed Pump is the well fluid itself, hence it cannot be lost and never wears out. The longer, 18 foot lengths provide about thirty feet of fluid seal between the loose-fitting telescoping tubes. Any slippage must travel this distance in an annular space about 10/1000" in width, take a complete change of direction, and displace the fluid packing between the tubes which is acting as a buffer against slippage.

Here's the PROOF!

RECORD OF PUMP PERFORMANCE

Company – [redacted]
Field – [redacted]
Pump Size and Type – Fluid Packed-2" X18' Positive Pull
Date Installed – Orig. Const. 1931
Gravity – 40°
Casing Pressure – 75 lbs.
Average Daily Production 60 bbls.
Net Daily Production – 15 bbls.

Date – Mar. 15, 1935
Well No. – [redacted]
Tubing Depth – 4252'
Gas—Cu. Ft. – 250,000
Emulsified or Free – Free
RPM – 22
Stroke – 40"

Positive Pull Type

See the Fluid Packed Pump Section in the 1935 Composite catalog—or write our nearest office for complete information.

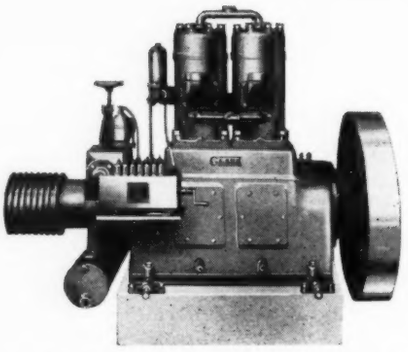
FLUID PACKED PUMP CO.
BOX 64 • LOS NIETOS, CALIFORNIA • U.S.A.
MID-CONTINENT AND TEXAS DISTRIBUTION
FLUID PACKED PUMP CO.—MID-CONTINENT
2 S. E. 29TH ST., OKLAHOMA CITY, OKLAHOMA
Gulf Coast Headquarters: 409 Velasco St., Houston, Texas
London Office: Coventry House, South Place, London E.C. 2, England

A MODERN PUMP FOR MODERN CONDITIONS
Protected by Patents No. 1545474, 1545475, 1549175, 1621046: others pending.

Clark Brothers Company's Bobcat Pumping Engine

CLARK BROS. COMPANY, Olean, New York, recently announced a new Bobcat pumping engine in their bulletin No. 200-62.

This is the first two-cycle, vertical, multi-cylinder, medium-speed engine to be offered to the trade, designed especially for geared- and chain-driven pumping units, the manufacturers state. In placing this unit on the market Clark Bros. Company has done so with the belief that there has been a long-felt need for an engine of this type combining the smooth operation of a multi-cylinder engine and the simplicity of the two cycle design.



In building the unit Clark Bros. Company has taken advantage of its years of experience in the development and design of two-cycle engines.

"Koroseal," a New Plastic Material

A NEW plastic material, said to be superior to rubber for the manufacture of a wide variety of products, has been developed by the research departments of The B. F. Goodrich Company, Akron, Ohio.

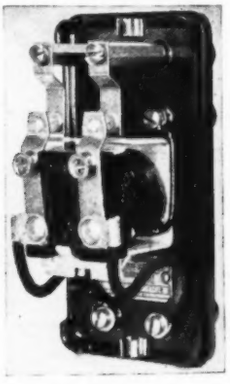
The material, perfected after extensive experimentation, may be molded into any shape, resists the action of various chemicals injurious to rubber, and possesses even greater flexing life than rubber, according to Goodrich engineers.

Known as "Koroseal," the new Goodrich product is not expected to replace rubber in general use but will be applied in some instances where rubbery consistency, combined with superior resistance to certain oils and chemicals, and where flexing, is required.

Westinghouse Low-priced Auxiliary Relay

A SMALL, sturdy, low-priced auxiliary relay for use on a.c. or d.c. and suitable for switchboard or panel mounting is announced by Westinghouse Electrict and Manufacturing Company, East Pittsburgh, Pennsylvania. The type SK auxiliary relay for switchboard mounting has a molded cover or molded cover with glass front; the front connected panel mounted relay uses no cover. Both types have two independent contact circuits that may be easily adjusted for circuit-closing or circuit-opening service. For two independent opening circuits additional material must be added to the standard relay.

Designed for continuous duty at rated voltage, the SK relay is obtainable for circuits up to 550 volts a.c. or 440 d.c. Ranges up to 250 volts can be used for intermittent duty up to approximately three times their continuous value. The



relay can be supplied with a coil for any current value up to five amperes.

Relay is adapted for any thickness of panel material from ⅛ in. (steel) to 2 in. (slate). The molded terminals are 1⅛ in. long, being ample for steel-panel mounting. For thicker panels, extension terminal studs are furnished.

Each contact will carry 12 amperes continuous and 20 amperes for one minute. The non-inductive rating follows:

Volts	Interrupting Rating, Amperes d.c.	Interrupting Rating, Amperes a.c.
24	12	20
48	6	20
115	3	20
230	1.25	10
550	0.25	3

Now-REDUCE CYLINDER WEAR

"Sealing Pressures Since 1888"

Wherever you may look throughout the oil and gas fields you will find COOK'S GRAPHITIC IRON Piston Rings at work keeping down operating and maintenance costs. More and more COOK'S Rings are being used because operators of internal combustion engines are demanding the economies in operation and maintenance that result from the superior wearing properties of COOK'S GRAPHITIC IRON. Among these economies are: reduced cylinder wear—added years of engine life and the savings that attend fewer shut-downs for repairs.

use the accepted COOK'S GRAPHITIC IRON PISTON RINGS for less cylinder wear

Specify COOK'S Rings on your next order — obtain the economies of COOK'S GRAPHITIC IRON in Perma-Tensioned Plain Rings and the exclusive advantages of the COOKTITE Sealing Ring engineered to restore new engine performance after cylinders have become worn — or write for informative literature.

C. LEE COOK MANUFACTURING CO.
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New York Cleveland Los Angeles Baltimore Chicago Tulsa New Orleans San Francisco

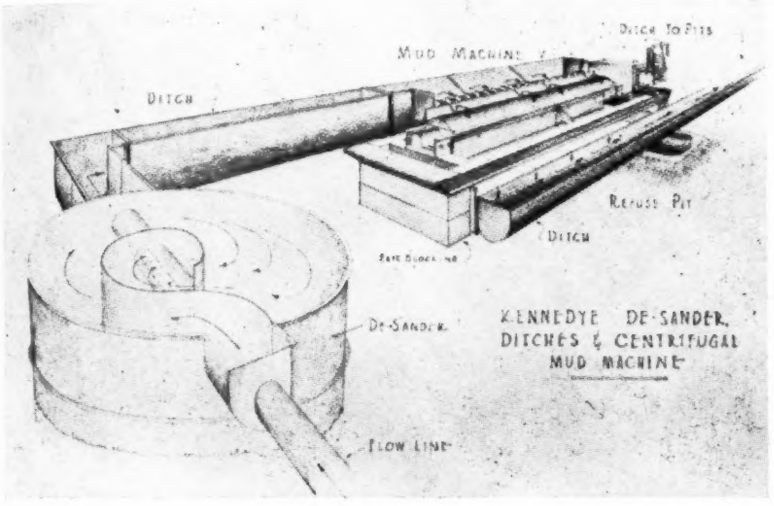
Kennedye Centrifugal Mud Machine

THE Kennedye centrifugal mud machine and process, recently placed on the market in the Mid-Continent area by Mid-Continent Supply Company, Fort Worth, Texas, was perfected after several years' research and collaboration with a number of major oil companies, contractors and drillers with view toward elimination of many common difficulties encountered in drilling of oil wells such as stuck drill pipe, heaving, caving, bridging and blowout. The Kennedye machine makes use of one of the oldest principles in colloid chemistry; namely, making colloidal mud by agitation, keeping it free of gas and air by agitation, and breaking up the gel chains by agitation (lowering viscosity).

The centrifugal mud machine proper is composed of a heavy H-beam frame, a 6-in. shaft with a double helix of rubber broken at frequent intervals encased in a horizontal steel shell. The shaft operates proper. This allows the larger cuttings the necessary time to soak up water and become fluid while the heavier materials (shell, gravel, boulders, coarse sand) remain in the bottom from where they are jetted away.

Mud fluid made by the Kennedye machine is a fine quality mud, for it is kept thoroughly mixed, free of air, gas and cuttings, and is constantly made finer and finer as the well progresses. The finest material, deposited on the walls by the weight of the fluid column, is constantly being replaced in the circulating mud.

According to the distributors, the success and safety of any drilling well is to a large extent dependent upon the percentage of colloidal material in the mud, less solids, less free water, less entrained air and gas, and the Kennedye mud process keeps any drilling fluid in this condition. Other advantages of the machine are that it gives the operator complete



on torque and thrust bearings being driven by a small twin steam engine. Approximately one horsepower is required. Attached to the machine proper is a distributor ditch which permits flooding the entire screen regardless of the volume produced by the pump. Below the shaft is an oil well type screen wound backwards so that the flat side is next to the rubber and the larger opening below the screen prevents clogging. This screen is wound to approximately 40-mesh. Coarse sand, gravel, and the like, which will not pass through 40-mesh, is carried forward, dropped below the machine whence it is jetted to the refuse pit. The good mud which has been thoroughly agitated enters the mud pit from below the machine. Any entrained air or gas has been released by this violent agitation.

In operation of the Kennedye centrifugal mud machine the returns coming directly from the well enter a settling tank; this circular tank with a conical-shaped bottom has a capacity of 50 barrels of fluid. On the interior of the tank an arrangement of spiral baffles forces the incoming fluid laden with cuttings to travel in a spiral direction from outside to center, slowing the velocity materially. Only the lighter fluid is skimmed off the top from where it enters the mud machine control of weight, viscosity, percentage of free water and gelation. The distributors state that the percentage of water may be controlled to any desired amount, the gelation may be kept low because the gel chains are broken up by driving them through a fine oil well screen; this also keeps the colloidal content high. Weight may be governed by the formation drilled, the desired viscosity and the percentage of free water. Unless adjacent to a blowout (charged surface sand) this weight will be sufficient to shut off any water, gas or oil sand pressure leaving a liberal allowance for swabbing effect of drill collar and bit.

The Kennedye centrifugal mud machine will be on display at the Mid-Continent Supply Company booths at the Oil Equipment and Engineering Exposition in Houston, Texas. Other products distributed by Mid-Continent Supply Company on exhibit are: Cummins Diesel engines; the Mid-Continent automatic relief valve for oil pipe lines, manifolds and pump installations; Williamsport wire rope; Midwest welded fittings; Ludlow valves; Bethlehem rods; Pittsburgh plug valves; Naylor surface casing; Mid-Continent liner pumps; Harrisburg forged steel products; Electroloy materials; and National Tube Company products.

KEEP FLOWING WELLS *Flowing* with THE CAVINS

Don't kill a flowing well because the tubing is "bridged" with sand. It may never be as good again.

It is not necessary to pull the tubing to clean out with The Cavins; and the total cost of a complete cleaning-out job with this modern tool is less than the cost of pulling a wet job. It is run inside the tubing, and is the only clean-out tool of its type that will operate successfully in all fluid levels. It sucks up the sand bridges all the way to bottom (does not drive them down), and the well starts to flow again.

With all sizes immediately available and 24-hour service, The Cavins provides the easiest, quickest, cheapest and best way to clean out and keep flowing wells flowing. Write for descriptive bulletin.

THE CAVINS COMPANY

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On Baker Cement Floating Equipment

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Beyond the collapsing strength of your casing insures complete safety.

-2-

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A Bakelite Ball Valve "double seals" against live rubber and Bakelite; leakproof under any pressure.

-3-

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Only Concrete and a small amount of Bakelite to drill up — no metal or other fragments left in the hole.

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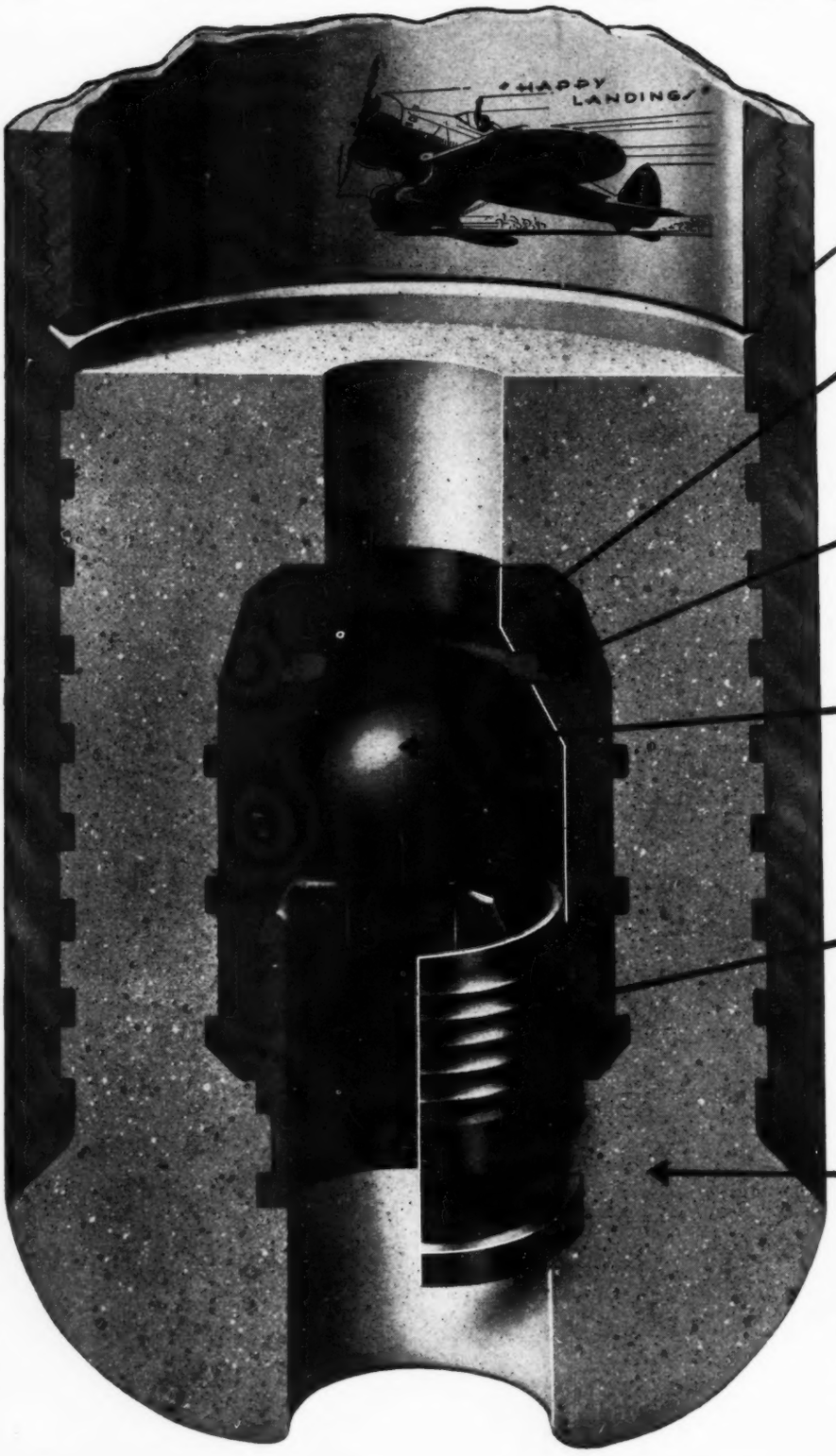

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and one on April 26, in the Plaza Hotel. Subjects to be considered include "Paraffin and Allied Production Problems," "Blow-out Prevention in High Gas Pressure Areas," "Accident Prevention," "Vocational Training," and "Tool Joint and Drill Pipe Failures." Among the invited speakers are George A. Hill, Jr., president of the Houston Oil Company, Houston, Texas, and Institute vice-president for production, and President A. D. Simpson, of the Houston National Bank of Commerce.

The program committee follows: Chairman, C. E. Sutton, The Pure Oil Company, Houston; Lyle Cashion, Gulf Production Company, Houston; G. B. Corless, Humble Oil and Refining Company, Houston; E. S. Durward, Shell Petroleum Corporation, Houston; F. E. Heath, Sun Oil Company, Dallas; L. B. Holland, Phillips Petroleum Company, Midland, and J. E. Warren, Carl B. King Drilling Company, Dallas.

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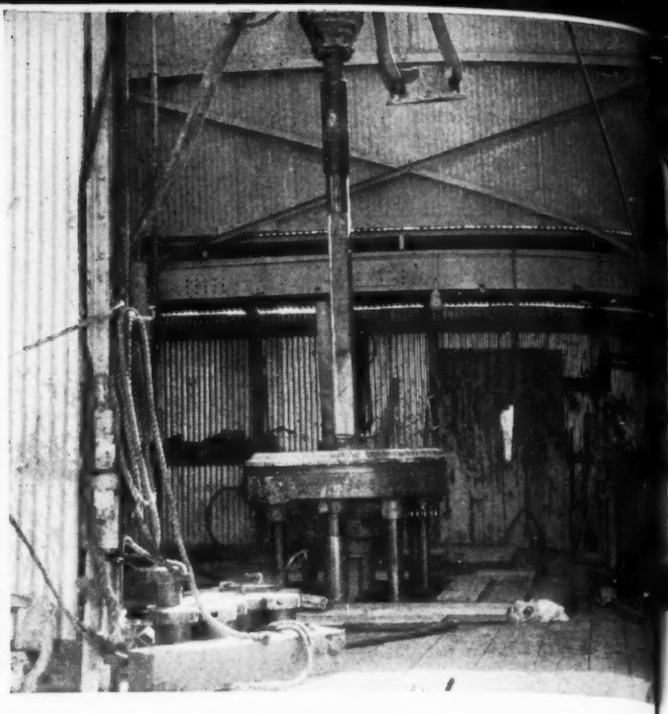


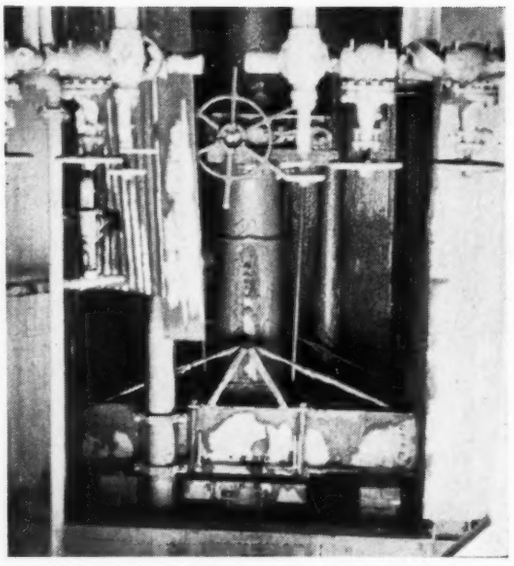
The rig floor of well No. 58-19-V showing arrangement of machinery

By ROY SILENT
Chief Engineer, Petroleum Securities Co.

Middle Dome Pressures at Kettleman Hills Necessitate Best Equipment and Careful Drilling

THE drilling of wells in the Kettleman Hills area has brought forth many material improvements in the quality of equipment used for the work and it is probable that "by and large" no better equipped oil field exists in the world. The drilling of the North Dome area in the past has proved most interesting but work has now become largely standardized. However, due to the slopes of the underlying strata, new problems are constantly arising in the matter of casing programs and casing perforation. Further, the capabilities of the underlying formation to spring surprises on the unsuspecting driller do not seem to be in the least exhausted.

Drilling in the North Dome area has an advantage in that flows of gas and water under pressure are encountered at depths sufficiently great to permit the use of mud-laden fluid that does not have to be unduly heavy in order to maintain control of the well. In the Middle Dome area, however, such is not the case and elaborate precautions must be taken in order to prevent surprise blowouts. The equipment here must be of the highest order to insure complete control at all times.



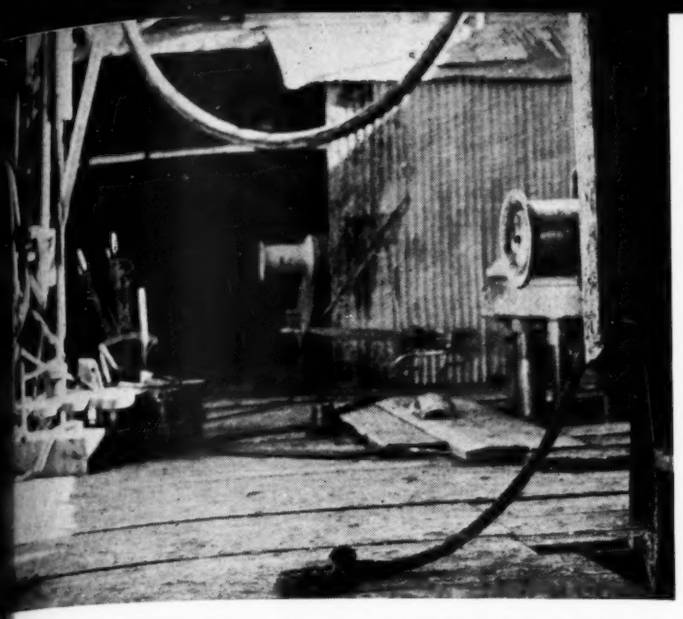
The cellar provides for adequate gates and packers for pressure control. Middle Dome, Kettleman Hills field, California

In the drilling of the well No. 58-19-V, Sec. 19, Twp. 23 S., R. 19 E., which was recently completed, elaborate preparations were made to guard against heavy flows of high-pressure salt water and high-pressure gas, which were encountered before the final "pay" was reached. Drilling in this area is also complicated through frequent losses of circulation. An elaborate basement and cellar were provided in this rig to permit the installation of adequate gates and packers for pressure control, a total of 26 ft. from the cellar floor to the rig floor being made available for this purpose. In order to insure uninterrupted hoisting service, an additional drawworks and engine were installed on the opposite side of the rig from the main hoisting equipment; and the "dead end" of the casing line was secured to this second drum, making auxiliary hoisting service immediately available if required.

No difficulties are encountered in this area in setting the surface strings, the usual plan being, for example, to set 13⅜-in. at a depth of about 5500 feet. As a matter of fact, in the well mentioned, a flow having a pressure of approximately 4000 lb. was encountered at 5480 feet. The estimated flow of water to the surface with the casing full of fluid was 5500 bbl. per day. From this point downward until the next string is set at about 7600 ft. this pressure and water flow must be fought.

The behavior of the formation at this time is interesting, as it is almost impossible to force fluid into the formation if the pressure is raised, but on the other hand, the water flows readily into the well if the pressure is even slightly lowered. From data obtained from wells previously drilled in this area and from the experience encountered in drilling No. 58-19-V, it was found that the formation acted much as a semi-permeable membrane; and from the data at hand a curve was constructed.

This curve showed that the pressure in the formation remained in the state of equilibrium at a bottom-hole pressure of 4000 lb. per sq. in. at 5500 ft. in depth. Yet pressure as high as 4500 lb. would force only two bbl. of fluid into the formation; and pressure as high as 5100 lb. only 5½ bbl.



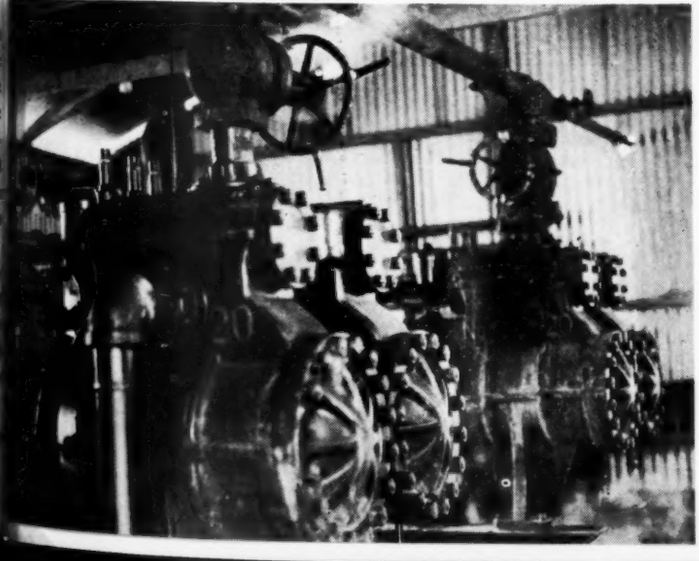
The rig floor from the main operating side showing the reserve drawworks installed opposite. Middle Dome well

hour. On the other hand, lowering the pressure to 3400 lb. would permit approximately 18 bbl. an hr. to enter the well and 3275 lb. would allow 40 bbl. an hr. to enter.

It was therefore necessary to maintain the mud pressure at the bottom at 4000 lb. per sq. in., which required the mud fluid to be carried at 105 lb. per cu. ft. or approximately 14 lb. per gallon. Any reduction of this pressure would immediately result in a slug of water, which would thin out the mud and curdle it. It was further found that it was necessary to withdraw the drill pipe very slowly from all points below the 5500-ft. level, as the piston action of the bit and drill collar was sufficient to reduce the pressure and allow a considerable volume of water to enter in the wake of the bit. In spite of the utmost precaution this occurred numerous times and the slug of water thus admitted was eliminated by watching for it at the flow pipe and diverting it to waste so that it could not contaminate the mud generally.

The conditioning of the mud was given considerable and careful attention as the cost of building mud weighing 105 lb. per cu. ft. proved an expensive matter and it was desirable to use the mud for as long periods as possible. Unfortunately, the drilling of the brown shale furnished considerable material of colloidal dimensions that served to increase the viscosity and shear of the mud to a very high degree in a short period of time. It was further necessary to employ physio-chemical means of reducing the viscosity to keep the mud workable. This was very successfully done since it was found possible to reduce the viscosity of the mud from say 125 centipoises to 35 centipoises in the time required for the

Circulation is an important factor in the high-pressure Middle Dome wells. Here is shown the steam ends of the 15x7¾ x 20 mud pumps used on well No. 58-19-V



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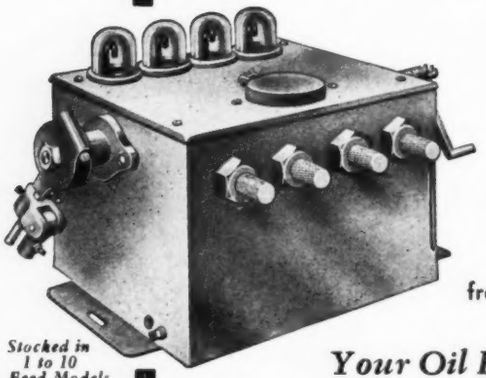

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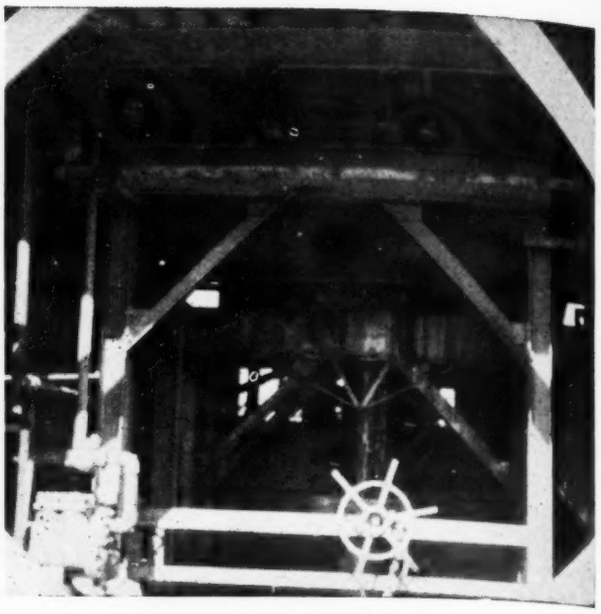
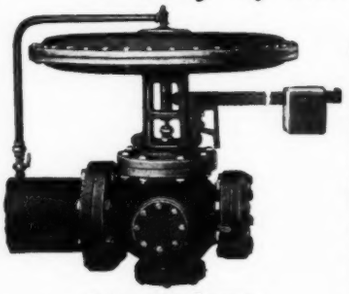


The basement of well No. 58-19-V below which is the cellar. The 20-in. I-beams support the hydraulic rotary

circulation to make one round trip. In this manner the same batch of mud was maintained without difficulty for periods of six to eight weeks.

Generally speaking, pressure may be controlled in this area by use of weighted mud that is conditioned and cleaned, provided that the formation pressures are encountered at depths sufficient to permit the use of mud weighing not over about 110 lb. per cu. foot. It has been the experience of the

Valve Seats Renewed without Disturbing the Body of the Regulator



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THE Fulton Low-Pressure Regulator can be fitted with new valve seats if desired, with the body of the regulator remaining undisturbed in the line. Plain directions will be mailed to any user on request. This regulator is capable of taking relatively high inlet pressures and reducing to the correct pressure for use. If the purpose is to deliver a very low pressure, the diaphragm surface is made very large so that the regulator becomes highly sensitive to any variation at the outlet and adjusts itself to compensate. Action is exact, positive and sure. Changes of pressure on the inlet side are therefore without effect on the delivered pressure. If gas supply should fail, automatic cut-off is provided. This Regulator is easy to install, never sticks, gives unfailing satisfaction. One of a line of regulators, known and approved for forty years, for all needs of gas control.

The Chaplin-Fulton Manufacturing Co.
28-40 Penn Avenue Pittsburgh, Pa.

writer that mud weighing over 110 lb. per cu. ft. is very difficult to maintain over any considerable period of time, as such mud requires a very high colloidal content to keep the weighting material in suspension.

The result of such colloidal content is that the viscosity and the shear increase to such a point that the mud is almost unpumpable and the cost of reducing agents to keep it fluid is high. Where pressures necessitating mud weighing over 110 lb. per cu. ft. are encountered, it is believed that the well should be put under pressure control, utilizing mud of say not over 85 lb. per cu. ft. and the drilling continued through stuffing boxes with flush-joint drill pipe and sufficient back pressure to overbalance the force of the intrusive bodies of water or gas.

Making Plans for Natural Gasoline Association Meeting May 1-3

The board of directors of the Natural Gasoline Supply Men's Association met at Tulsa, Oklahoma, March 25, for the purpose of discussing the entertainment program for the annual convention of the Natural Gasoline Association of America, which will be held in that city May 1, 2 and 3.

By vote of the directors the personnel of committees will remain the same as last year with one new member being added in each case. Members of the committees are as follows:

Smoker entertainment committee: J. H. Satterwhite, Westcott & Greis, Inc.; M. F. Waters, Hanlon-Waters Company; M. H. Kotzebue, Tulsa Boiler and Machinery Co.; L. G. Marsh, Taylor Instrument Company.

Dance committee: P. W. Raigorodsky, Petroleum Engineering, Inc.; A. J. Kerr, Pittsburgh Equitable Meter Company; Dave Fields, Tulsa Boiler and Machinery Company.

Luncheon committee: George W. Probst, Clark Brothers Company; C. C. Clover, Westcott & Greis, Inc.

Membership committee: M. F. Waters, Hanlon-Waters Company; W. D. Moorer, The Moorlane Company; William F. Lowe, secretary of the association.

The secretary outlined for those present the program as now planned, and stated that a large attendance is in prospect. The feature of the program will be a discussion on volatility trends in motor fuel and their possible effect on automotive design. The discussion will be between representatives of leading refiners and engineers representing the Chrysler Corporation and the General Motors Corporation. Actual road tests with 1935 model cars, using more volatile fuels, are being planned.

Members of the board of directors of the association are P. W. Raigorodsky; E. H. Triphaus, Taylor Instrument Company; J. H. Satterwhite; M. H. Kotzebue, and J. A. Lupfer, Worthington Machinery Corporation of Oklahoma.

Tagliabue Opens New Branch Factory at Dallas, Texas

To more conveniently serve its customers in the South Central States, the C. J. Tagliabue Manufacturing Company, of Brooklyn, New York, has opened a new branch factory at 1916 Jackson Street, Dallas, Texas. This branch takes the place of their old Shreveport, Louisiana, address, which has been closed.

The prime function of this new branch factory will be repair work, with special attention to emergency orders. In addition, however, adequate stocks of all TAG standardized instruments will be maintained.

A. G. Koenig, southwestern district manager for the Tagliabue company, will be in charge at Dallas.

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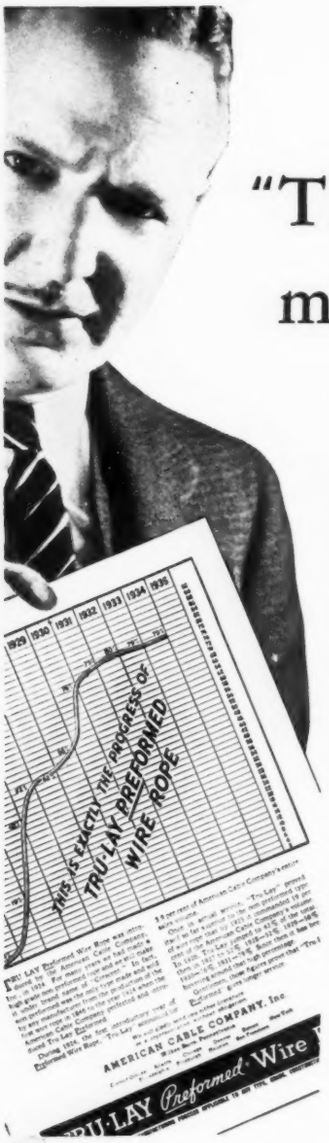
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